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[OFFICIAL NOTICE.]

New England Association of Gas Engineers.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS,
OFFICE OF SECRETARY, 26 CENTRAL SQUARE,
EAST BOSTON, MASS., Jan. 16, 1907.

The Thirty-sixth Annual Meeting of the New England Association of Gas Engineers will be held at Young's Hotel, Boston, Wednesday and Thursday, February 20th and 21st, 1907. Papers by several men prominent in the industry are being prepared, and several topics likely to bring out a lively discussion are being arranged for. An excursion to some of the largest gas power plants in this part of the country can be had, if the members wish it. Persons wishing to join the Association are requested to send their names to the Secretary. The annual dinner will be held Wednesday evening. More detailed announcement will be made later.

N. W. GIFFORD, Secretary.

BRIEFLY TOLD.

CURRENT COMMENT.—

IN addition to furnishing gas and electric light free to aid the work put upon the Relief Committee of Cincinnati, O., brought about by the extremely high water mark in the river, the Union Gas and Electric Company has forwarded to Mayor Dempsey a check for $500 for the fund for the relief of those who suffered by the flood.

ON the 26th ult., Mr. Thomas Dolan, President of the United Gas Improvement Company filed with the City Controller of Philadelphia, Mr. John M. Walton, a statement showing that during the quarter ended December 31st, last, the Company had been paid for 2,053,735,730 cubic feet of gas, which yielded a revenue to the city, under the terms of the lease between it and the latter, of $187,145.57.

THE Capital City Gas Company, of Des Moines, Ia., has engaged fine office and showroom quarters on the first and second floors of the fine building erected by the Des Moines Life Insurance Company at Seventh and Grand avenues.

THE subject for the last meeting of the Quiz Club of the Rome (N.Y.) Gas, Electric Light and Power Company was the suitable one of "Gas Freezing." The matter was put forth in Superintendent Fields' best style, and the debate that followed was interesting and instructive.

MR. C. H. NETTLETON, President of the New Haven (Conn.) Gas Light Company, after a study of the question, to the general phases of which he has given close attention for 3 years or more, and which involved at least one trip abroad, has, with the hearty assent of his associates, put into operation a profit sharing plan, in which all of the employees, save those in the class of executive officials, may share, provided each has been in the service of the Company for a continuous twelvemonth. Roughly stated, the sum of 8 per cent. will be credited quarterly upon the wages paid during the preceding 3 months, and when the total amount credited to an employee equals the market value of one or more shares of the Company's stock a certificate representing that amount of stock will be registered in his name. The stock becomes his personal property and he may do with it as he sees fit, provided he offers it for sale to the Company first before offering it in the public market. The only restrictions regarding the operation of the plan are these: "If an employee be discharged for any cause, except drunkenness, insubordination, commission of some crime, or destruction of the

SMITHSONIAN INSTITUTION FEB 5 1907

Company's property, he shall receive his balance in full, but if discharged for these causes, or any of them, he shall forfeit the entire balance. If an employee leaves the Company on his or her own volition, one-half of the amount of the credit shall be paid in cash, except in the case of a woman leaving the Company on the occasion of her marriage, in which event the Company shall pay the full amount of the balance. In case of the death of any employee the balance shall be paid to his legal representative in full."

THE proprietors of the Mifflin County (Pa.) Gas and Electric Company, whose headquarters are in Lewistown, and who control the gas and electric supply of that and nearby boroughs, have arranged a fitting plan for celebrating the fiftieth anniversary of the introduction of gas into Lewistown by the old Lewistown Gas Company. This plan is none other than the announcement that from the 1st inst. the gross selling rate is to be put at $1.60 per 1,000 cubic feet, with a discount of 10 cents per 1,000 on all accounts settled before the 20th of each month. The rate for a supply on fuel account remains as heretofore—$1.25 per 1,000. Turning back to the JOURNAL, dated May 15th, 1863, we find the following respecting the history of the Lewistown Gas Light Company: It was chartered in 1856, and was capitalized in $30,000. It was paying in 1863 dividends at the rate of 6 per cent. per annum; the population was 3,000, and the selling rate was $3.10 per 1,000. General Manager McCabe and his associates have reason for congratulation over the success that is attending their efforts in going on with the supply of gas to the many thousands now within the territory of the old Company, more especially when it is remembered that there was no electric lighting in the initial period of its history.

JUST forward a line or two of inquiry to Mr. Peter Young, at Pittsburgh, Pa., respecting the gentle reminders that the James Gardiner, Jr., Company is putting out as an earnest that it is still in the field for favor.

A RECENT issue of the *Gazeto do Pono*, of Bahia, Brazil, gives Mr. A. B. Slater quite a shining bit of mention over the fact that he is quite the engineering thing in Bahia at present. Of course, we take it for granted that it is known that the Senor Slater is reconstructing the gas works in Bahia—in fact, the task on hand is construction rather than reconstruction. "Al.'s" listing includes the naming of 11 engineering societies to which he belongs, and in Brazil, as in America, he is known by his good works. Senor Lewis J. Carder, formerly of Coney Island, N. Y., and now of Rio Janeiro, who is on the Slater staff, is also figuring as a great man from the Provinces. May their shadows never grow less; and they (the shadows) are in no sense to be classified in the order penumbra.

THE Milwaukee (Wis.) Gas Company has 50,640 consumers on its ledgers. In 1863 (the Company was chartered in 1847) the population of Milwaukee was some hundreds under 25,000, and the selling rate was $3.50 per 1,000. At that, the Company was returning to its shareholders a dividend of 10 per cent. per annum.

AN interesting and instructive visit was made about a fortnight ago to the works of the Sioux City (Ia.) Gas and Electric Company by the Class in Chemistry of Morningside College. The visit was made at the invitation of General Manager Kellogg, and the Class went through the plant under the direction of Prof. W. W. Scott and his alert assistant, Mr. Earl Fry. The inspection was made while the apparatus was being worked to its utmost.

MR. JOHN H. FINDLAY'S host of friends will be glad to know that he is meeting with great success in the management of the plant of the Goshen (N. Y.) Illuminating Company, the complete control of which is now vested in him. When he is through with the rebuilding and extensions now in hand the residents of that garden spot of Orange county will be enjoying the most satisfactory gas service ever given there. Good for the host of Ogdensburg.

WE regret to have to chronicle the death of the Hon. Daniel Russell, for many years prominent in the direction of the Malden and Melrose Gas Company. He passed away at his home in Melrose, the evening of the 23d ult., after a brief struggle with pneumonia. Deceased was born in Providence, R. I., July 10, 1824, and eventually became a resident of Melrose in 1847. His name at the end was a household word in the business, political and social circles of the State. He had been organist of Wyoming Lodge of Masons for 35 years, and his beautiful home in Melrose was the frequent scenes of hospitality that was as generous as it was enjoyable.

ON February 15th the shareholders in the East St. Louis (Ills.) Gas Company will sanction the arrangements made by its Directors for a consolidation of its interests with those of the Belleville (Ills.) Gas and Electric Company. Both are controlled by the American Gas Company, of Philadelphia.

[Continued from Page 140.]

Report of Committee on Electrolysis, Prepared for the American Gas Light Association, and Submitted to the American Gas Institute on Behalf of the Former as a Contribution to the Proceedings of the Latter.[1]

Remedy and Conclusions.—"At its annual meeting in 1900, the American Water Works Association appointed a Special Committee on Electrolysis, 'To make recommendations for the guidance of the Association in dealing with the problem, and to formulate for the approval of the Association an expression of the attitude of the Association on this question.' The report of this Committee was published in 1900 in the Transactions, so that all the members might have an opportunity to carefully read the report before voting on it at the next annual meeting in 1901. At that meeting the report was unanimously adopted, and the resolutions were unanimously passed, as an official expression of the attitude of the American Water Works Association on the question of electrolysis. The report in full is as follows:

[Mr. Maury includes this report here; it will be found under separate heading at the end of this section.]

"Every examination that I have made of piping systems since the above report was published has served only to strengthen my conviction of the truth of all the statements contained in the report, and of the wisdom and propriety of the resolutions embodied therein.

"The adoption of a properly constructed and maintained conduit system or double trolley system will absolutely prevent further injury to your pipes, and this result can be attained by no other known practical method.

"It is my opinion that to make the change from the single to the overhead double trolley system would be the very best business policy for the street railway companies.

"I, therefore, recommend that your honorable committee adopt such reasonable measures as may result in securing the change from the single to the double trolley system in the shortest possible time.

Respectfully yours,

[Signed.] DABNEY H. MAURY, Consulting Engineer."

Following the above report, the Water Committee and the Street Railway Companies agreed,

"That the matters now in dispute between the City of Richmond and the Richmond Traction Company, and the Richmond Passenger and Power Company, in its own right and as successor of certain other lines of street railway formerly operated on the streets of the city of Richmond by other street railway companies, relative to the amount of damages now due and unpaid to the city of Richmond by said companies, by reason of the destruction or injury to the water mains and pipes of the city of Richmond by electrolysis, be, and the same shall be, submitted to the award and final arbitrament of 5 arbitrators as provided for in the articles of agreement to be executed as hereinafter provided."

The bankruptcy of the street railways, however, has prevented any action under this agreement up to the present time.

New Bedford, Mass.—The following is taken from the results of 2 electrolytic surveys of the water pipes of New Bedford, by Mr. A. A. Knudson, published in the "Annual Report of the Water Board" for 1903:

Summary of Preliminary Report No. 1.—1. "The tests and examinations at points *G* and *E* result in finding a current of an average of 5 amperes flowing north on the force main between these points and led off from the main to the tracks of the railway by the 2-inch service pipe, which accounts for this pipe being frequently destroyed at this place. While this amount of current is comparatively small, it is quite sufficient to cause the damage it has.

2. "Tests and other examinations indicate that this small current flowing north between *G* and *E*, is only a remnant, in other words only a portion which slips past the crossing at Beaver Dam. The main part, we believe, goes by way of the reservoir, when cars are south of Beaver Dam, and the most of it passing out of the main at some point not yet discovered west of the crossing.

"* * * Mr. Goff's letter of May 18th, 1903, puts the matter concisely from the railway point of view: 'Our electrical department recommends that the track be bonded to the water pipe at Whitestone Brook and a distance of several thousand feet beyond.'

1. This report is limited to the consideration of direct current electricity, and is, therefore, contingent upon future developments in the use of alternating current electricity for traction purposes.

"* * * I cannot too strongly indorse the position which you have taken. One extract quoted from your letter of May 19th, covers this position: 'In my opinion, the city of New Bedford will not be at all content for you to prevent further electrolysis by making our water pipes a direct medium for the conveyance of your return current.'

"It is not unusual for railway companies to advise this method, it being the least expensive of any for avoiding the trouble, but such a scheme as converting your force main, a splendid steel structure, into a medium for returning railway current, should not be seriously considered for a moment, * * *.

"The complete remedy is an insulated return, or better known as the double trolley; in such a system there is no connection with the rails or earth, and consequently there is no current passing to underground mains. Methods for mitigating the evil may be advanced by the railway people, such as a system of supplementary track feeders over the entire line and rebonding tracks. Unless such a method were very carefully and well constructed, it is doubtful if such a plan could give the assurance of permanent safety.

"In any event the bonding of this main to the rails should not receive consideration for the reasons stated."

REPORT NO. 2.—COMPLETED.

"Upon examination it was found that several lengths of pipe were badly softened by electrolysis at the spigot end as shown.

"The worst damage was found a little back of the joints, where nails can be seen driven in the soft material. The joints were the ball-and-socket pattern. The pittings and furrows were from ¼-inch to ⅜-inch deep. The 3 lengths when seen by the Superintendent were condemned as unfit for further use, owing to their weakened condition. There were other pittings upon these lengths, but the greater damage seemed to be concentrated at the spigot ends, the result, without doubt, of railway current passing through the pipe in the direction from spigot to bell.

SUMMARY AND CONCLUSIONS.

"* * * The connection spoken of between the condenser pipes and switchboard at the power house form an indirect connection between the water main of the city and the rail return.

"This is mentioned here as in case it is found in future to be a means of inducing further flow of current upon the mains to their detriment, the railway company must not be relieved of responsibility in the matter. * * *

"The 6-inch pipe taken from the river will furnish an apt illustration of the damage resulting at the joints of mains from railway currents flowing through them.

"This evidence which happened to be discovered at this time may be regarded as proving the wisdom of your Board in recently refusing, under our advice, to allow the railway company to 'bond' the steel main to their tracks, the result of which would have been to divert a stronger current through this and other important mains connecting with same, such as the long 36-inch main and there increasing the liability of damage at the joints through electrolytic action in both systems, the steel and the cast iron."

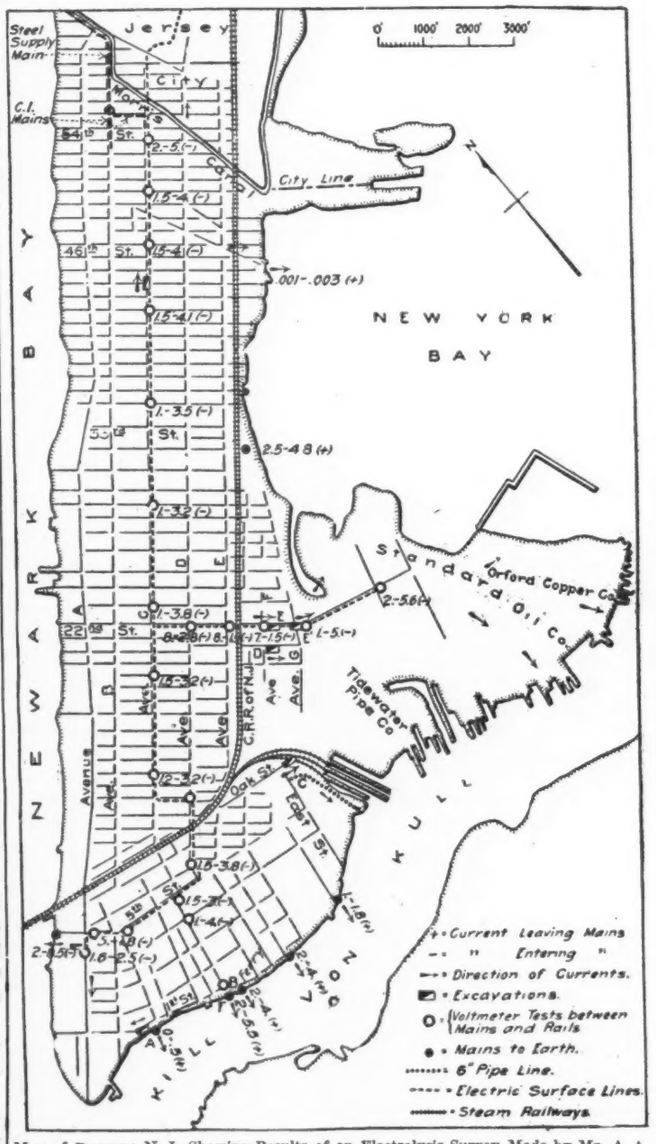
Bayonne, N. J.—The following description of an electrolytic investigation made in Bayonne is condensed from the *Engineering News*, Nov. 17, 1904. The cuts and table are not reproduced here.

A break in an important branch water main at Bayonne, N. J., about 3 months ago, led the authorities of that city to have an electrolysis survey made by Mr. A. A. Knudson. The results are summarized in a report to the Mayor and Common Council of that city, and reveal serious conditions as to stray electric railway currents, and electrolytic corrosion of underground metals in Bayonne.

The Bayonne case presents a clear and simple aspect, because the electrolytic effects are of the same character throughout the entire outer edge of the city. The case differs therein from the ordinary case, where there is a fairly well defined "positive district" in which most of the damage occurs.

Voltmeter readings were taken over all of the lines. All of the tests between mains and rails show mains negative to rails, the currents leaving the tracks and taking the mains in all streets of the city where they parallel. There is no "positive area" in the city, in the sense of mains positive to rails. This is due to the fact that the power house is located in Jersey City, some 5 miles from the central part of Bayonne.

The readings on Avenue C between mains and rails are such as may be expected upon a fairly well-bonded road, and the same may be said of the tracks upon 22d street. The 5th street line, however, presents a case of rank negligence, so far as the track return is concerned. The voltmeter readings and other observations show the tracks unbonded at the joints, and not carrying current except perhaps when the car is a few feet away. Differences of potential up to 12, 18 and 25 volts have been found. Residents along the route report frequent illuminations at the track joints. Since the rails afford practically no return, current makes its way back to the power house by the water mains to the shore, thence, through the waters of New York Bay and Newark Bay, to the power house in Jersey City, which is located on the marsh near the shore. (See map.)



Map of Bayonne, N. J, Showing Results of an Electrolysis Survey Made by Mr. A. A. Knudson, September, 1904.

The measurements show that there are two paths by which current enters the mains and passes back to the power house. One of these paths is in a northerly direction by way of mains passing into Jersey City; some of the current goes by way of the 20-inch main which crosses the canal bridge at Avenue D and connects with the mains in Jersey City, and some goes by way of the large supply main which passes into Jersey City further to the west. The second path has been found to be by way of the shore ends of practically all mains that extend to tidewater, the current going thence through the water to the power house. As the city is surrounded by salt water and marshes in which several mains are imbedded the conditions along this second path are very favorable to electrolytic destruction.

CONDITIONS WHERE BREAKS OCCURRED.

Main in East 22d Street.—The corrosion and break of the 12-inch main in East 22d street are most important, as upon this main several important industries at Constable Hook depend for water. This main, burst during the night of August 6, 1904, causing much loss in time and money to works depending on same for water; owing to the break

being under tidewater, great trouble and expense were incurred in making repairs. Besides this, it is stated that some 4,000,000 gallons of water went to waste before the leak could be located and water shut off.

This leak took place in the made street, crossing the salt meadows, about 300 feet east of Avenue F, and near a culvert through which a tidal creek passes under the street. It was evident from a few tests that railway current was passing out of the main into the soil at this point, thus causing the damage.

The current flow was determined by the "fall of potential" method at two places upon this main, one at either side of the marsh where the break occurred (*E* and *E*, on map), to determine how much of this current was straying into the marsh. These determinations show that the current upon the main is flowing east, with a decrease of current in the marsh, which decrease is accountable for the break. This decrease, representing current leaving the main at this point, undoubtedly is at present causing further damage to this main. For instance, referring to the readings taken at the comparison test:

Avenue F: Maximum 51.1 amp. } = average 36.5 amp.
Minimum 21.9 " }

Avenue G: Maximum 25.5 amp. } = average 20.0 amp.
Minimum 14.6 " }

Average loss..... ..... 16.5 amp.

This average loss of 16.5 amperes, or 45 per cent. of the average current at Avenue F, is escaping from the main into the marsh during the heavy traffic lasting about 2 hours each morning and evening. During the remaining 20 hours the current varies according to the traffic on the cars. Permanent connections have been made upon the main at Avenue F, with insulated wires, and the ends brought to the surface of the street through a pipe covered with a screw cap, so that the future current flowing through this main may be conveniently measured. Two confirmatory tests were made of the potential differences between the main and soil of the marsh. One, nearest where the break occurred, showed a reading with main positive to soil of 0.3 to 0.7 volt.

The other 55 per cent. of the current remaining on the 12-inch main is distributed through various other pipes and metals at the lower Hook, and thence to soil, causing damage wherever it leaves the metal for the soil. One of these places is an 8-inch main near the Orford Copper Works, Lower Hook, which burst on March 21, 1904. This pipe also showed clear evidence of having been destroyed by electrolytic action.

Main in First Street.—Another electrolysis break occurred on First street near Rathbun avenue in March, 1903 (Point *A* on map). This is a 6-inch main and was replaced. The main is reached by tidewater and is positive to the soil. The flow of current through the main was west, with a variation from 5.2 to 12 amperes; as the current is flowing towards the west, further damage is looked for upon this main. (See Appendix II., following.)

Main at the Coal Docks.—This main enters the salt marsh near East avenue and Oak street (point *C* on map), and until recently was under tidewater in the marsh. About 420 feet of this pipe have been removed and about the same length was abandoned in the marsh, making about 840 feet destroyed. Each one of the 25 lengths taken out of the marsh shows the characteristic marks of electrolysis.

The electrical measurements on the main now in use show clearly the cause of electrolysis and the destruction of the pipe removed. Tests made near the meter box, where the main enters the marsh at East avenue and Oak street, show a flow of current going east, ranging from 2 to 4.6 amperes. Potential tests show that the main is positive to the marsh by upwards of 1 volt.

These conditions, therefore, are all favorable for bringing about just what has happened, viz.: The destruction by electrolysis of this entire line of cast iron pipe.

Lead Service Pipe.—Another most pronounced case of electrolysis was discovered while the examination was in progress (Sept. 19, 1904) by the bursting of a lead service pipe supplying water to annex to School No. 5, located on 21st street and Avenue F (point *D* on map.)

A portion of this pipe remaining in the ground was in a very similar condition to the piece removed. The electrical conditions show that railway current is leaving this pipe for the marshy soil, and another failure of this pipe is predicted in a short time. (See Appendix I., following.)

Summary.—All of the damage to the city water mains caused by electrolysis is due to the railway current passing from them to tidewater soil. No case has been found where it passes back to the rails; and in this sense there is no so-called "positive district" in the city.

The remedy for electrolysis in Bayonne rests with the street railway corporation operating its cars there. There are other ways than the "ground return" to bring currents back to the power house in Jersey City. So long as the "ground return" is in use so long will the currents find their way to the mains and pass out of them in the manner which we have described. There are copper return systems in use, insulated from the ground, from which no injury to underground mains by electrolysis is caused.

The full extent of damage by electrolysis to the water mains in Bayonne may not be known until those in the marshes and water front have been removed. Several pipes as in 22d street being under tidewater, it is impossible to examine them. It is safe to conclude, however, from the experience with the 6-inch pipe to the coal docks (point *C* on map) and from what has already occurred on the 12-inch main in 22d street, that the latter main is practically ruined for about 1,500 feet where it passes through the marshy soil. The loss of the 840 feet of 6-inch main through electrolysis has already been stated.

The destructive effects upon the joints of mains where these railway currents are flowing through them have not yet been mentioned. This feature of electrolysis is very difficult to locate because it is hidden. The result, however, is to cause joints to leak, causing much expense to the city for repairs. This flow of current prevails at present through a large part of the entire piping system, and if it has not already appeared it will in time make itself known.

Appendix I. to Bayonne Report, Oct. 14, 1904.

Since the completion of this report the following additional casualties to water pipes have occurred at Bayonne:

The lead service pipe at annex to School No. 5 (point *D* on map) mentioned in the report, with the prediction that "it would again fail in a short time," was again found leaking, and on October 10th the entire length, about 120 feet, leading from the main to the school building, was removed and a galvanized iron pipe put in its place. This iron pipe is subject to the same effect of electrolysis, but it will probably take a little longer time to cause its destruction than the lead pipe. The lead pipe which was removed has the usual stamp of electrolysis throughout its entire length.

Another service pipe destroyed by electrolysis is being removed from First street, at the old Staten Island ferry (point *B* on map). One portion of this 3-inch iron pipe was found full of holes caused by the escaping current. It is also stated that the service pipe at the new ferry slip adjoining is eaten through, in about 18 months' time. Electrical tests, at both the old and the new ferry slips, show the current flowing from the pipes to the Kill, and fully explain the cause of the failure at both places.

Appendix II. to Bayonne Report, Oct. 31, 1904.

A further break occurred on the 6-inch main in First street, Oct. 31st. This failure (point *F* on map) took place about one block west of Avenue C. A soft spot in the main about 2 inches in diameter was blown out, and was in such position that the stream of water forced its way up through the soil and over into the Kill von Kull some 50 feet away, very similar to a stream directed from a fire hose. On this account there was no damage by water to nearby property. The shutting off of water to repair this break, however, caused a serious loss and inconvenience to residents and others on this street. The large manufacturing establishment of the Safety Insulated Wire Company was compelled to close its works for an entire day, leaving several hundred men idle, owing to loss of water which the main supplied.

The electrical tests again at this point show the main highly positive to the waters of the Kill, which agrees with the previous tests. The readings were highest at the foot of Avenue C at the ferry, where they ranged from 2 to 5.5 volts; a little further west where the break occurred they ranged somewhat lower, and were 0.5 volt further west at Rathbun avenue. East of Avenue C, or the ferry, the conditions are quite similar to those on the west side. This main near the fracture was softened entirely through the iron, with pittings upon other parts of its surface. The data collected shows that this break is a clear case of electrolysis, for which the railway currents are directly responsible, and, as before stated, further breaks may be expected while these currents are upon this main.

A sub-station is at present (1906) in course of construction in Bayonne which will supply the current for that section of the electric road. The electrolytic conditions will be entirely changed when this station is in operation.

Boston and Vicinity.—The following is from the *Engineering Record*, July 29, 1905:

"There is probably no city in which electrolysis phenomena are being watched more carefully than in the district containing the mains of the

Metropolitan Water and Sewerage Board of Massachusetts, and in the report of the Chief Engineer, Mr. F. P. Stearns, for last year, some very interesting notes on the subject are given. * * * In the annual report for the year 1903 detailed descriptions were given of the injury done to 48-inch pipes in Cambridge, 24-inch pipes in Chelsea and 12-inch pipes in Lynn, and also of an experimental test of an insulating covering of asphalt and burlap which was being made by the Boston Elevated Railway Company. On April 6, 1904, this covering, which was applied in November, 1902, was removed from one length of 48-inch pipe for the purpose of examination. Before the covering was applied the pipe was carefully cleaned and the pits dug out and located. Upon removing the covering many new pits were found, and in some cases one large pit was found where there were two or three separate pits before the covering was put on. The number of pits in the pipe had increased from 80, in 1902, to 496 in 1904. The railway engineers suggested that possibly the pits were not all dug out before the pipe was covered, and, therefore, re-covered it for a further test. They have since made the following experimental tests, which indicate that the covering has little if any value under some circumstances:

"A short piece of 4-inch pipe, covered in the same manner as the large pipe, was buried in dry earth in a box, and a cast iron plate was buried 1.25 feet from the pipe. In one test tar was used in the covering, in another asphaltum. The pipe and plate were connected in the regular trolley circuit of 500 volts. While the earth was dry the resistance between the pipe and the plate with the tar covering was 700 megohms [1 megohm = 1,000,000 ohms], and with the asphaltum covering, 34 megohms. The earth was then saturated with salt water, and the resistance quickly diminished, and after 7 to 10 days disappeared.

"For the purpose of diminishing the injury which was being done to 2 lines of 36-inch pipe crossing under the Charles river near the power station of the Boston Elevated Railway Company, in Cambridge, two 48-inch insulating joints were set in July, 1904, one on either side of the river. Each of these joints was composed of two flanged pieces of 48 inch pipe, bolted together with a gasket of pure rubber ½ inch thick between the flanges. The bolts joining the flanges were covered with rubber tubing ½ inch thick, and the nuts were insulated from the casting by means of a washer of rubber ½ inch thick. The joints have a resistance of from 100 to 200 ohms when the pipe is filled with water, and are inclosed in waterproof chambers, to prevent the entrance of the ground water.

"These joints reduce the quantity of electricity leaving the 36-inch pipes in the river from 25 to less than 5 amperes, and reduce the quantity flowing along the pipes toward the power station from 65 to 40 amperes. The joints were expected to protect the pipes in the river at the expense, to some extent, of other portions of the pipe line; and the measurements of currents appear to show that the effect has been substantially as expected, as the quantity of electricity leaving the pipe between Western avenue, Brighton, and the river, was increased about 25 amperes. As these joints reduced the quantity of electricity flowing along the pipe line, the railway company desired to set similar joints at other points, and late in the year an arrangement was made for the setting of 4 additional 48-inch joints. As the amount of current flowing along the pipes at different times depends upon the amount of power developed at these times at the different power stations, many observations are necessary to determine the average quantity flowing even for a single day, and these have not been taken since the last joints were installed; but enough measurements have been taken to warrant the statement that the introduction of the joint at one of the places has substantially stopped the flow of electricity along the pipe at that point. The conditions have been changed so as to increase the amount of electricity leaving the pipe north of the joint, but there appears to be at present not more than 40 amperes flowing along and leaving the pipe line, in place of 90 amperes; and there has also been a very marked reduction in the difference of potential between the pipes and the rails of the street railway company.

"The measurements thus far taken appear to indicate that the effects of setting an insulating joint somewhere near the middle of a pipe line, one portion of which is electrically positive and another negative to the car tracks, are as follows:

1. To stop the direct flow of electricity along the pipe line at the point where the joint is set, and to reduce considerably the amount of electricity flowing along other parts of the pipe line.

2. To lower the average potential of the pipe line on the negative or power station side of the joint.

3. To raise the average potential of the pipe line on the positive side of the joint.

4. To maintain a difference of potential of several volts between the positive and negetive sides of the joint, and to produce conditions tending to increase electrolytic action at that point, unless the joint is carefully located in dry ground.

5. To cause a new distribution of electrical conditions, under which the two sections of the pipe line become similar to the original line, with one portion of each positive and the other negative to the car tracks, so that the number of positive areas is increased by one for each joint.

"Both in August and November, 1903, the attention of the officials of the Boston and Northern Street Railway Company was called to the serious injury which had been done to the Board's pipes, both in Chelsea and Lynn, by the currents of electricity returning to its power stations. Excavations, made in November in Lynn, showed that there were pittings in a 12-inch pipe 0.45-inch in depth, leaving only 0.25-inch of the original thickness of iron. As it was not deemed prudent to continue to risk the failure of this pipe line, it was relaid during the past year for a length of 593 feet. All of this pipe was laid in 1898, and when removed it was badly decomposed, and in several places very little of the original metal of the pipe remained. The officials of the railway company were notified that the pipes were to be relaid before the work was commenced, and were asked if they desired to adopt any preventive measures, but they did not do so; and on December 5, after the pipe was relaid, measurements showed that there were 20 amperes of electric current leaving the relaid section. It is probable that, if nothing is done to alter the conditions, it will be necessary to again relay these pipes not later than 1910.

"The regular annual survey to determine the relative electrical potential of the Metropolitan pipe lines and the street railways tracks, and the amount of electricity flowing on the pipes at the several gauging stations, was made in April. In making these surveys voltmeter readings were made at each station every 12 seconds, for a period of 5 minutes. The figures are obtained from readings taken between 9 A.M. and 4 P.M. during the months of March and April, and do not represent the extreme results which would be obtained during the hours of maximum travel. The average of the readings, compared with similar readings made in 1903, shows that the electrical pressures have been generally reduced during the past year over the entire distribution system.

"At a few points, however, the conditions are worse than in 1903. At one place in Brookline the voltage between the pipe and the rail has increased from 2½ to 5 volts, possibly due to increased traffic on the Boston and Worcester line. At a place in Milton the average voltage has increased from 18 volts, in 1803, to 22 volts, in 1904, and the maximum from 35 to 60 volts. This is due to poor track construction, and lack of return feeders on the Old Colony Street Railway Company. Early in the year the Boston and Northern Street Railway Company was notified that there was a large difference of potential between the Board's pipes and its tracks in Stoneham, and that a large quantity of electricity was flowing along the pipe. During the past year the railway company has relaid the tracks and provided better returns for the current, so that the conditions have been greatly improved; but even now there is considerable current flowing along the pipe.

"In January the attention of the Old Colony Street Railway Company was called to the fact that a current of from 15 to 45 amperes had been measured flowing on a 12-inch pipe in Hyde Park, with differences of from 5 to 18 volts between the pipe and the rails. In June the pipe was uncovered at several points for examination, and pits about $\frac{1}{16}$-inch in depth were found on several pipes. A service pipe of the Hyde Park Water Company was found to be resting upon the 12-inch pipe, making an electric contact by means of which about 10 amperes of electricity passed from the Metropolitan main to the pipes of the Hyde Park Water Company. By raising the service pipe and breaking the electric connection, the flow of electricity along the pipes was reduced about one-half."

Chicago, Ills.—In order to ascertain the exact electrical condition of the gas piping controlled by the Peoples Gas Light and Coke Company, a complete electrical survey of the city of Chicago was made in the spring of 1901, and the following information has been supplied:

The surveys were undertaken to determine how much of the piping and what portion of it were positive to the rails and the earth; that is, the portion in which the current was leaving the pipes for the earth and where electrolysis was taking place. Wagons were equipped with voltmeters and ammeters and a crew consisting of a driver and 4 men, and readings of potential differences were taken on every block in the city of Chicago. These were obtained by connecting one voltmeter terminal to the rail, and the other to some portion of the main, or to a pipe connected to the main, as to a lamp post, a drip pipe, or a service

pipe in the basement of a neighboring house. To determine the current strength, measurements were made of the potential differences between points on the main of known distance apart, and, knowing the resistance of a given length of the pipe, the amperes of current were calculated by Ohm's law. The direction of the current was also noted.

When the results were plotted, the city was divided into three kinds of districts: First, negative districts or the parts remote from the power houses, where the current is leaving the rails and flowing through the earth and entering the pipes; second, positive districts in more or less immediate proximity to the power houses, where the current is leaving the pipes, and where most of the electrolysis is taking place; third, the regions between the negative and positive districts, where the current sometimes enters and sometimes leaves the pipes. The extent of these intermediate districts varies according to the load.

The positive voltage was found to range from $\frac{1}{10}$ to 30 volts, although for the most part the average was from 2 to 6 volts. The current being carried by the pipes varied from 0 to 150 amperes and averaged about 20 to 60 amperes. The city was then charted from a map and the positive areas were found to be as follows:

	Feet.
North Side	280,000
West Side	541,100
South Side	635,425

making a total of 1,456,525 lineal feet, or 276 lineal miles, which is about 13 per cent. of the total mileage of mains in Chicago.

Since the gas companies could not prevent the flow of electricity to their pipes, upon the pipes and off of them again, their efforts were directed toward the prevention of the flow of current from the pipes *into the moist earth*. To this end, all of the pipe joints in the *affected* districts in Chicago have been bonded, and the current taken off through metallic conductors, at various intervals, instead of being allowed to go into the earth.

While the bonding of the pipes to each other around the joints, and connecting them to the negative side of the dynamos in the respective power houses of the street railway companies would entail disadvantages and danger in the shape of vastly increased current flow on the pipes, nevertheless this method appeared to offer means of substantially remedying the existing conditions, and of saving the piping in the affected districts from total and early destruction.

To do this, it was necessary to bond and connect the different pipes so that they formed the *best* return circuit for the stray currents that reach the pipes, and in this way a flow of current to the pipes which is harmless was induced, and not away from the same, which is known to produce electrolysis. To this end, electrical measurements were made, and knowing the size and resistance of the rail and of the pipe and of the joints [?] in each, the size and amount of copper to bring about these results were determined upon. As a general thing copper wire of about $\frac{1}{4}$ inch diameter (No. 0000) was used for the bond around each joint in the pipe. To install these, each joint of pipe in the positive district was uncovered and a hole was drilled on each side of joint, and a plug was driven into the hole and soldered; then a bond wire of the above size was soldered in, to connect the plugs. Voltmeter readings were taken during the entire progress of the work, and at intervals heavy connecting wires were run from the pipe system to one or more return wires installed on the poles carrying the feeder wires at the side of the street. These connecting wires were installed about every 600 feet, the space varying, of course, with the size of the main and with the volume of current to be returned, the intention being to connect at the points where the potential was highest.

It was found that the best results could not be obtained by simply connecting the pipe system to the rails or to the underground return feeders of the railways, hence independent return feeders were placed upon the pole lines. These varied in size from $\frac{1}{4}$ inch in diameter (No. 0000) to 1¼-inch (1,000,000 cir. mils). These return feeders were led into the power houses and connected to the negative bus bars.

By these means the positive area has been reduced to less than 2 per cent. of the mains which were undergoing deterioration at the time the work was taken up. There are a few small positive areas left, due to local causes, in which the voltage is so low that it was not deemed necessary to go to the expense of bonding, and doubtless there exist and will continue to arise small affected areas, due to broken rail bonds, etc., but the bulk of the trouble appears to have been overcome.

Considerable difficulty was experienced in bonding the pipes on account of the varying conditions. The bonding on one street would cause conditions on another street to change, and difference in the amount of traffic also caused very perplexing variations. The bonding of the gas pipes altered the conditions in regard to the water pipes, and to the telephone cables, and in some instances it was necessary to bond the lead sheaths of the telephone cables to the return system of the gas pipes.

While bare conductors would have been entirely adequate for the return circuit, bare overhead wiring is not permitted in Chicago, hence the return cables were all insulated.

For the maintenance of this system it is essential that the street railway companies retain good bonding on their rails and that the joints in the gas pipes be kept tight and electrically conductive.

Detroit, Mich.—The results of an electrolytic survey of the water and gas pipes of Detroit, made by Mr. A. A. Knudson, in 1905, are given in a report addressed jointly to the Board of Water Commissioners and the Detroit City Gas Company. The following abstract of this report is given with the permission of the above parties:

The present situation in Detroit, as a result of previous attempts to avoid damage by electrolytic action, is briefly as follows:

In 1896 the first examination authorized by the Board of Water Works appears to have been made under the supervision of the then General Superintendent, Mr. L. N. Case.

At that time there were three electric railway companies operating in the city, the Citizens, the Detroit and the Fort Wayne and Belle Isle Railway Companies. The latter was not considered a source of danger, its system being comparatively small,

The plan for protection which was pursued is outlined in the following extract from Mr. Case's report: "The necessity, first, is to keep the electricity off the pipes as much as possible in those districts where there is a tendency to overflow from the rails. This can be accomplished by providing a more liberal system of return conductors. The uninterrupted conductivity of the rails should be first insured, an additional feeder of copper wire being sometimes used independent of the rails. The next step is to arrange special return wires from the pipes to the rails or to the return cables in what are known as the danger districts, which are almost entirely within a short radius of the power houses."

The quotations are made for the purpose of establishing the origin of the bonding system found generally in vogue in Detroit upon the water mains.

The bonding of gas mains to the railway returns was probably begun in June, 1903. It was found necessary to place bonds around the lead joints of the 12-inch wrought iron main in Riopelle street, to prevent their melting out, owing to the heavy currents flowing through them, which were caused by its connections with the railway returns. A few other bonds have been placed upon gas mains at other points in the city.

We will now consider the situation as found at the present time. Since the first bonds were placed upon the water mains the railway companies have combined and are now operating under one management, called the Detroit United Railway Company. This company has freely co-operated with the Water Department in efforts to avoid electrolysis. They have installed bonds and connections to pipes with their returns at their own expense, first obtaining the consent of the parties owning the same, and are keeping watch through annual voltmeter surveys of danger districts in all parts of the city.

Over 150 measurements were made upon the water mains, and nearly as many upon the gas mains. The danger points in Atwater street refer to gas entirely. One service pipe was found leaking where it was exposed by the excavation for the new 10-inch water main, which leak was due to electrolysis.

This (+) condition of gas pipes is, without doubt, caused by both the fire main and the water main in the street being bonded to the railway return. The recent bonding of the fire mains has brought about this result in several places in the city, one marked instance being at Cass avenue and Lafayette street, where both water and gas mains are positive to those mains, and another at Miami avenue and Witherall street; at the latter place the 2 water mains and the fire main have been bonded together. The 4-inch gas main found at this opening was considerably damaged by electrolysis.

Jefferson Avenue.—Several gas service pipes have been destroyed through this part of the street, and about 30 feet of 4-inch cast iron main replaced with new pipe, all owing to electrolysis. Between October 17th and 31st, the 4-inch cast iron gas main was bonded to the 12-inch wrought iron gas main by the railway company with a view to stopping further damage.

It should be understood that as the 12-inch wrought iron gas main is connected to several railway negatives, both underground and overhead, which lead direct to the power house, bonding the 4-inch gas main to it, practically connects the entire system of gas mains in this vicinity to the railway returns. The same may be said of another case

of bonding at Fort and Riopelle streets, where the 4-inch gas main was bonded to the 8-inch water main, the water main being already connected to an overhead negative.

At Fisher avenue we find a maximum flow of 341 amperes. This is further added to as shown at Field avenue, making 373 amperes, the flow being west at both tests. At Bellevue avenue (same time of day as at Field avenue) it is 148 amperes.

At Meldrum avenue the 42-inch main turns north and thence goes through Congress street. As the pipes and rails on Jefferson avenue are bonded at nearly every street running north and south, a flow south is found, where tests have been made, to the pipes in Jefferson avenue as far as Riopelle street. At this point all pipes, both water and gas, are bonded not only to rails, but to special cables both underground and overhead, running to the power house at the foot of this street.

There are two large gas mains in Riopelle street crossing Jefferson avenue, one a 12-inch wrought iron main previously spoken of, and the other a 16-inch cast iron main; both are carrying railway current, but the 12-inch main, owing to the screw coupling joints making the best conductor, as against the lead joints in the cast iron main, carries much the greater current.

The drawing [not reproduced here] shows the method of bonding around the several cast iron parts in the 12-inch main containing lead joints. This copper cable was placed in this way so as to prevent the lead joints from melting, as had been the case in one or two instances due to the heavy current passing through the main since it was connected to the railway negatives.

The other two one-million cir. mils cables connect with other larger cables which lead to the power house.

The Twenty-four Hour Test.—In view of the heavy flow of variable current at times upon this main and the desirability of establishing the readings at any time in 24 hours for future comparison, a series of highest and lowest millivolt [1 millivolt = 0.001 volt] readings was taken every 5 minutes, beginning at 5 P.M., October 17th, and ending at 5 P. M., October 18th.

The current flow in amperes has been deduced and the whole plotted upon the accompanying curve sheet. On this sheet the power house log is also plotted for the same hours. It will be noted that the variation of current strength of the power house load is faithfully reflected by the variation of current strength on this main, making the identification of the source of current on the main complete.

Increase of Railway Current.—As a traction system expands and more cars are added, more current is required to move the same, consequently an increased amount of current will return by the mains.

Another reason for the increase of current strength upon underground mains is the bonding of mains to rails or to negative busbar, also bonding one set of mains to another, such as gas mains to water mains. An idea of such an increase is given in the following comparative tables, in which an average is obtained of 3 readings selected from the evening load at the power house and 3 readings from an evening load on the gas main, showing the per cent. of increase in the past 2 years.

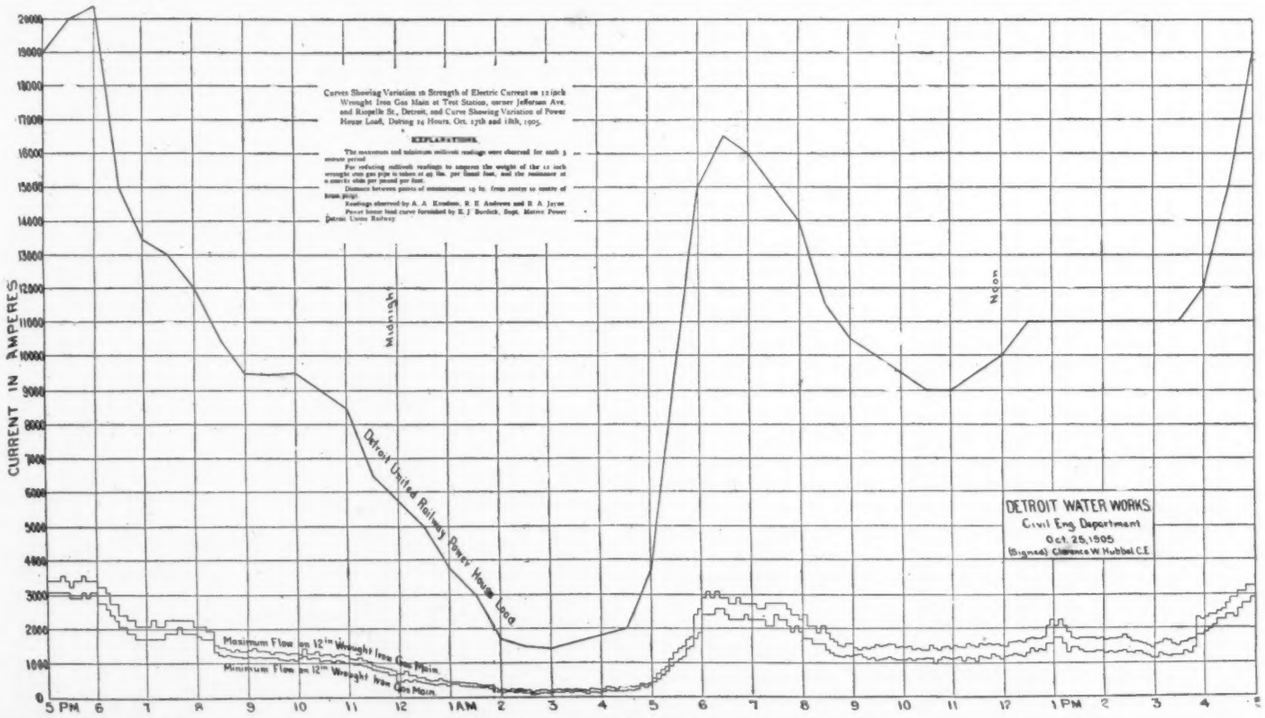
Switchboard Readings D. U. Railway Power House During Evening Rush Hour. Years 1903 and 1905.					Current Flow on 12-Inch Wrought Iron Gas Main. Years 1903 and 1905.				
Time.	Date.	Amps.	Ave.	Inc.	Time.	Date.	Amps.	Ave.	Inc.
P.M.	1903 May				P.M.	1003 May			
5.00	28	11,000			5.00	28	2,290		
5.30	"	13,500	13,000		5.45	"	3,050	2,848	
6.00	"	14,700			6.00	"	3,205		
	1905 Oct.					1905 Oct.			
5.00	17	19,000			5.00	17	3,400		
5.30	"	20,000	20,000	53 p. ct.	5.45	"	3,600	3,410	20 pr. ct.
6.00	"	21,600			6.00	"	3,250		

Fire Department Mains.—This system of mains is used solely for fire protection and they are generally known and spoken of as "Fireboat Mains," as during fires, water from the Detroit river is pumped through them by a fireboat.

These mains, which are so important to the city, have been seriously affected by electrolysis. We have already referred to one of the effects of current flow through them—the possibility of damage at joints.

These mains, as well as the gas and water mains, are connected with the negative return to the power house, the connections, with few exceptions, having been made during the past summer.

Current Action at Joints.—During this survey the question arose, in the event of further bonding being allowed from gas and water mains to fire mains, how much added flow could be delivered to the fire mains without danger of melting some of their lead joints. [The details of the tests made to determine this are omitted, but the conclusions are given on page 184.]


CURRENT IN AMPERES
Midnight
Noon
Detroit United Railway Power House Load
Maximum Flow on 12" Wrought Iron Gas Main
Minimum Flow on 12" Wrought Iron Gas Main
DETROIT WATER WORKS
Civil Eng. Department
Oct. 25, 1905
(Signed) Clarence W. Hubbel C.E.
5 PM 6 7 8 9 10 11 12 1AM 2 3 4 5 6 7 8 9 10 11 12 1PM 2 3 4 5

Conclusions and Suggestions.

Bonding.—"The bonding of water mains to railway return conductors, as a protection from electrolysis, was commenced in Detroit in 1896, and has continued to a more or less extent since then. The traction system was small at that time as compared with the present. It was supposed then, no doubt, that the same method would answer for large, as well as for small systems.

"Where the safety of all underground pipes is considered in the

[The details of the tests made to determine this are omitted, but the conclusions are given on page 184.]

streets of a city, we are of the opinion that it is not wise to depend upon the bonding method as a final cure for electrolysis, especially where a large traction system using a ground return is in operation.

"Where such a system has been in vogue for several years, however, as in Detroit, it is not advisable to make any sudden or radical change without first having a substitute in use known to be equally efficient.

"Referring to other methods of protection, we quote the following extract from A. V. Abbott's work entitled, 'Electrical Transmission of Energy,' 1904, page 102 (an authority on the subject), which we believe will apply to the situation in Detroit. After referring to damage by electrolysis to underground pipes, lead cables, etc., he says: 'On account of these difficulties the larger roads are now aiding the ground return by re-enforcing it with copper wire return feeders, looking in the near future to a more or less complete metallic circuit for the railway system.'

"While the *complete metallic circuit*, such as in practical use in New York, Washington and Cincinnati (conduit system and double overhead trolley) has not come into general use, the tendency, at least among large railway systems, as Abbott indicates, is in that direction and something of this kind should be adopted in Detroit.

"If the *complete metallic circuit* is installed there will, of course, be no further danger from electrolysis of underground mains. In the meantime the situation in Detroit will have to be considered and dealt with as found.

"The system of bonding, while it has advantages, has also disadvantages; for instance, where one set of mains, such as water mains, are bonded to the railway return conductors, other mains in the same streets are, on this acount, made electro-positive to them; and, unless also bonded, will be injured by electrolysis. This is the experience covering several years in Detroit.

"Another result from bonding: A much greater flow of current is invited upon the mains and electrolysis action at joints is apt to occur, especially when the currents are heavy. On account of these and other objections, we have never favored the method of bonding mains to rails or to negative returns, preferring means to keep currents off mains, rather than recommending means which make them a part of the return circuit to their detriment.

"In Detroit, however, we find at the present time the water mains and fire mains bonded and the gas mains also bonded to some extent. To prevent immediate electrolytic action upon the gas mains that are now in danger, it will be necessary to bond them also, at least as a temporary measure, until the railway company so improves its return system as to relieve the flow of current upon all underground mains in the city.

"Mr. Burdiek, Superintendent of Motive Power of the D. U. Ry., has informed us he stands ready to do this, and, therefore, we have reason to expect a substantial improvement in the near future in the reduction of the heavy currents now passing through some of the mains, as well as from one system of pipes to those of another system.

"*Joint Melting Test.*—This has been explained in detail and is important in determining what was hitherto unknown, viz., how much current a lead joint will stand before melting. It was found that a poorly made joint, with much less lead than the average, in an 8-inch water main, in service 38 years, tested in the open air, no water inside, required a current of 2,600 amperes for 14 minutes to cause the lead to melt. More perfect joints will stand more current without failure under the same conditions of test. In view, however, of weak or imperfect joints, such as may be in smaller water mains or in a gas main that is near the surface of the street, subject to changes of temperature and the consequent expansion and contraction, causing high resistance, it is not safe to permit any such flow of current through mains of any size containing lead joints.

"Taking all sizes and kinds of underground pipes, length of service, etc., into consideration, it is our judgment that a *maximum flow of* 900 *amperes is the highest that should be permitted upon any underground main, so far as danger of melting the lead joints is concerned.*

"*Electrolytic Action at Joints.*—Many joints have been examined, both gas and water, in the cast iron mains, interior as well as exterior. The result has been that, while in some cases evidence of electrolytic action has been found, as a whole no serious damage can be reported. The sizes of joints examined were from 4-inch up to 12 inch. As a rule sizes above 12-inch are not as much affected as the smaller ones, owing to greater surface contact of the metals and consequent lower resistance. It is to be observed, however, that the heavier the flow of current through the mains, the more chance there is for electrolytic action at the joints that are more or less imperfect. The flow of nearly 400 amperes on the 42-inch water main in Jefferson avenue is for this and other reasons deemed liable to be injurious at some joints in this main.

"The rails are well bonded, but the principal cause for diversion of current to this main is that the mass of cast iron in the main offers a conducting path which competes successfully with the rails in carrying capacity.

"Another instance is a joint in a 24-inch main which shows high resistance even after being newly caulked (owing to a leak) at Congress and Randolph streets. The flow at one test through this main was 203 amperes.

"This joint is still in service and exterior examination shows electrolytic action on the (+) spigot side close to the lead packing. As a rule, however, we have found very few joints showing high resistance. A reason given by Mr. Hubbell is that much care is given to the packing of all lead joints. This statement is borne out by personal observation.

"*The Twenty-Four Hour Test.*—The curve sheet shows the minimum and maximum strength of current during the 24 hours returning through the 12-inch wrought iron gas main. This main is connected by heavy copper cables to the power house which accounts for the heavy flow, at times above 3,000 amperes. The power house load current is also plotted on the same sheet and shows the similarity in variations at the same hours. The railway company has agreed to substantially reduce this flow upon this main by constructing additional track auxiliaries.

"Attention has been called to the increase of current strength of the traction system during the last 2 years. A short table shows 53 per cent. increase in 2 years' time at the D. U. Railway station, and 20 per cent. at the gas main above referred to, between the years 1903 and 1905.

"As it is probable that the same ratio of increase may be expected in future, unless a change is made, it is our opinion that a condition is being approached which makes it imperative that the railway company should make such change as soon as possible, at least before another summer's traffic commences."

New York City.—Electric Railway Systems.

The electric railways in New York city may be divided into 3 divisions: The elevated system, the subway system and the surface system; 600-volt direct current is used for operating each system. The electric power is chiefly generated in main power houses located on the water front, in the form of three-phase 25-cycle, alternating currents at either 6,600 or 11,000 volts pressure. This is converted into 600-volt direct current in a number of sub stations which are located at approximately equal intervals along the railway line supplied. Each sub station supplies this direct current to that section of the line which is within its own economic area For the purpose of discussing the question of electrolysis each sub-station may be considered as an independent power station. The arrangement of conductors to convey the direct current from the sub-stations to the moving trains is briefly described for each system in the following:

The Manhattan Elevated Railway.—The motive power of the Manhattan Elevated Railway was changed from steam to electricity during the years 1902 and 1903. The electric power is supplied from 7 sub-stations having an aggregate normal capacity of 61,500 kilowatts, which, at the 625 volts pressure generated, is equal to 98,400 amperes.

The positive supply feeder consists of a contact or third rail, installed on vitrified clay insulators. This contact rail weighs 100 pounds per yard and is made in 60-foot lengths of a special grade of low carbon steel giving about ⅛ the conductivity of copper. The rail joints are bonded with 4 solid bonds of drop-forged copper having a total conductivity slightly greater than the rail. The feeder system is divided into sections, each section covering the distance between 2 sub-stations. The contact rails for up and-down-town tracks are connected with cross bonds and usually no additional copper feeder cables are required. Current is supplied at each sub-station from the positive bus-bars through a 10,000-ampere circuit breaker and switch. The division between sections occurs opposite each sub-station, and a sufficient gap is left in the contact rail so that a single motor car cannot span across from one section to the next. This arrangement of the positive feeder system utilizes to the fullest extent the conductivity of the contact rails and enables the load to be equalized between sub-stations.

For the negative, or return, side of the direct current feeder system, the elevated structure and track rails are bonded together, thus forming a return path of great conductivity, so that the drop in the return circuit is very small. The track rails are 90-pound high carbon rails bonded together with one No. 0000 copper cable per joint. At intervals

of 90 feet, the track rail is bonded to the top chord of the longitudinal girder by means of a No. 000 flexible copper bond. The upper and lower chords of the longitudinal girders of the structure are bonded together with from one to four No. 0000 copper bonds, the number of bonds increasing toward the sub-stations. The structure and track return are connected, by means of bare, 1,500,000 cir. mils cables, to the negative bus-bars in the sub-stations.

The Subway System.—The subway system in New York city was opened for traffic during 1904 and 1905. The electric power is supplied from 8 sub-stations which are located at an average distance of 12,000 feet apart, and which have an aggregate power output of about 50,000 kilowatts, or about 80,000 amperes at 650 volts.

The positive feeder consists of a contact rail supported on insulating blocks of reconstructed granite. The contact rail weighs 75 pounds per yard and is made in 60-foot lengths of a low carbon steel giving about ⅛ the conductivity of copper. Each rail joint is bonded with four 300,000 cir. mils copper bonds. The contact rail is divided into two sections between sub-stations, one section being supplied with current from each sub-station. At a point half-way between sub-stations, the 2 sections are normally closed through quick-break switches. The contact rail is supplied with current through feeder cables which are connected to the rails at points along the lines. The feeder cables are all 2,000,000 cir. mils stranded copper cables, insulated with paper and covered by a lead sheath. For the return circuit, one rail of each track is used, supplemented by copper return cables. The other rail is used for signalling purposes. The negative cables are identical in size and insulation with the positive cables. The track rail is a high carbon rail weighing 100 pounds per yard of American Society, standard-section in 33-foot lengths. The joints in one rail of each track, used for the return current, are bonded with two 400,000 cir. mils copper bonds, placed under the splice bars. The negative bus-bars and return feeder cables are insulated from the ground. The tracks are also laid on a heavy stone ballast, which secures high resistance to ground.

The Surface System.—The Metropolitan Street Railway Company's system includes all the street surface railway lines of the Boroughs of Manhattan and the Bronx. Its lines in the Bronx also extend widely into the adjoining county of Westchester, its northerly termini in the villages of Tarrytown, White Plains and Mamaroneck being distant about 33 miles from the southern extremity of the system at the Battery. Within these limits, with about 500 miles of single track, it serves a resident population of nearly 2½ millions, of which all but about 400,000 are south of the Harlem river.

The surface railways in the Borough of Manhattan have insulated positive and negative conductors placed in conduits to convey the current to and from the moving cars. This is known as the double conductor conduit system, and, as the return circuit is completely insulated, there are no stray currents to endanger the pipes buried in the ground. There are at present over 200 miles of this conduit road in operation on Manhattan Island, all of which has been installed since 1896. The surface railways in the Borough of the Bronx and in the adjoining territory are operated by means of the single overhead trolley for the positive, and the rails, augmented by insulated return cables, for the negative or return circuit.

The Brooklyn System.—The Brooklyn Rapid Transit Company operates all but two of the surface railways and the entire elevated railways in the Borough of Brooklyn. These comprise a total of 544 miles of single track, of which 478 miles are surface and 66 miles are elevated tracks.

The electric power for operating the cars of the Brooklyn Rapid Transit Company is generated in 6 steam power stations; at 5 of these stations direct current only is generated, and at the other both alternating and direct current. Alternating current from the latter is supplied to 7 sub-stations which distribute direct current to the feeder system. There are therefore 13 stations in all which are centers of distribution of the direct current. On the elevated railway a third rail is used for the positive feeder, and the service rails and the iron structure are bonded together and are used for the negative or return feeder. The arrangement is similar to that used on the Manhattan Elevated Railway.

The surface railways are operated with a single overhead trolley for the positive feeder. For the negative or return circuit the rails are used, together with a number of negative return feeder cables. Where the tracks run close to the elevated structures they are also heavily bonded to this structure in a number of places so as to increase the conductivity of the return circuit. The rails used on the surface railway weigh generally about 100 pounds per yard, and a large number of the joints are electrically welded, giving a conductivity of 100 per cent.

(To be Continued.)

Rehabilitation of Customers' Piping.

[A paper read by Mr. John C. D. Clark, of St. Louis, Mo., before the National Commercial Gas Association.]

No doubt you have all noticed from time to time that gas properties are being purchased throughout the country, and that in almost every case the new owners are called on to spend a vast amount of money in rehabilitating the works, mains, services, meters, etc. This apparently is as far as anyone goes to put their own properties in good shape and earn more money for them. I have often wondered why the subject was not gone into a little further, and the pipes and appliances of the customer rehabilitated and put in good working order for the consumption of gas, and why this was not included in the general plan of rehabilitating the property so purchased.

Take any good-sized town that has been in existence for say 50 years. There is no question but that some of the customers' piping is entirely too small to serve the gas appliances which they now have, and if any more appliances should be added to their piping they would not get satisfactory results, neither would the gas company get satisfactory revenue.

And again, for years past gas companies have been running pipes for appliances, but I have never heard of a case where a gas company made a first installation that they ever ran any pipe larger than required by the appliance installed.

It has been common practice to go into a man's premises who is just commencing to use gas, and if his first purchase is that of a range, if the distance is not too great, to run ¾-inch pipe from the meter to the range. Then if a water heater were subsequently purchased the heater would be connected to this first piping; and if a laundry stove or other appliances were purchased, they would also attach them to this piping. In this way the original pipe which was installed is made to become the fuel system and, of course, becomes too small to serve the purpose for which it was installed.

Then, again, in the fitting work which has been done in the past, quite a number of pipes were trapped. These the gas company takes care of in the winter by blowing them out, but makes no effort to remove the source of the trouble. Summer time comes again and they forget all about it until the following winter.

A systematic inspection of piping and fittings in almost any town will show that somebody will have to go to considerable expense in rehabilitating customers' piping. At the time the majority of the buildings were piped, no attention was paid to sizes, to allow appliances to be introduced later for the use of gas, and even gas companies in years past have done considerable poor work themselves along the same lines. To remedy this trouble in the future and provide means for the customer to get all the gas he wants, and at the time he wants it, a set of rules and regulations for running piping for fuel is herewith submitted.

All new buildings should be equipped in accordance with same, and all pipe work run by the gas company should also be run according to these rules. These rules are based on the class of buildings the pipes are to be placed in. A residence that has a laundry, kitchen and 3 or 4 fireplaces should be figured about as follows: Each laundry to be counted as one opening; each kitchen to be counted as three openings; each fireplace to be counted as one opening.

At the time the building is built, pipe should be run to supply fuel appliances at each of these locations. If appliances are not to be installed at the time building is piped the fitter should be permitted to run the pipes to these locations and cap up. If in an old building the gas company receives an order to place a gas range, the necessary fuel pipe of the proper size should be run in the basement to supply all of the appliances that may be used in the building at any time.

In making the run through the basement, plug openings should be left in the fuel line opposite such fireplaces and other locations where fuel appliances are to be used. While, of course, on the start, this will cost the gas companies a trifle more for pipe, and a slight increase in labor, it will always leave them a fuel system in each of their customers' houses that will take care of any additional appliances that may be installed later.

In cases where Ruud or Monarch water heaters, or appliances of similar character, are to be installed, a separate exposed run should be run direct from the meter to the location of the appliance. When exposed piping is run it would be well to hang pipe so there is a ¼-inch clear space between pipe and ceiling to admit tools for the purpose of cutting run to insert tees.

In conclusion, would say that the matter of piping for appliances comes so close to the commercial man that it behooves him to be on the

alert and see that the proper sized piping is run to all appliances, so that all our customers may obtain satisfactory service from the appliance installed, and that we do not have to be continually tearing up their premises to run larger sized pipes. Put just a little more money into good, first-class appliances and good sized piping and you will not be under continual expense for maintenance or rehabilitation work. Everybody hates to pay out money for repairs, and when you are placing an appliance for anyone is the time to get the money required to have it installed properly, and do not place yourself in the position where you will have to go to anyone and ask him to spend money for repairs or maintenance.

Fuel System.—All piping for a separate fuel system must be taken from the service pipe, a separate meter provided, and must be run and used for supplying gas for fuel only.

Size and Length of Tubing and Greatest Number of Openings Allowed in Piping Buildings for Use of Fuel Gas.—This Table for Dwellings, Apartment Houses and Flats Only.—Length of Pipe in Feet.

Number of ½-Inch Openings.	½-Inch Pipe.	¾-Inch Pipe.	1-Inch Pipe.	1¼-Inch Pipe.	1½-Inch Pipe.	2-Inch Pipe.	2½-Inch Pipe.	3-Inch Pipe.	4-Inch Pipe.
1	15	50	80	100	150	200	300	400	500
2	..	30	60	100	150	200	300	400	500
3	..	..	40	100	150	200	300	400	500
4	..	..	20	80	120	200	300	400	500
5	..	..	..	50	100	200	300	400	500
6	..	..	..	30	80	200	300	400	500
7	..	..	..	25	70	200	250	350	500
8	..	..	..	20	60	150	250	350	500
9	..	..	..	...	50	120	220	300	500
10	..	..	..	...	40	80	200	300	500
11	..	..	..	...	35	70	180	250	400
12	..	..	..	...	30	60	150	220	400
13	..	..	.	...	25	50	120	200	350
15	..	..	..	...	20	40	100	150	300
20	..	..	..	...	...	30	70	120	250
25	..	..	.	...	...	25	50	90	200
30	..	..	..	...	...	20	40	60	170
35	..	..	..	...	...	...	30	40	150
40	..	..	..	...	...	...	20	30	120
45	..	..	..	...	...	...	...	25	100
50	..	..	..	...	...	...	...	20	80
65	..	..	..	...	...	...	...	...	60
75	..	..	..	...	...	...	...	...	40
100	..	..	..	...	...	...	...	...	20

No illuminating flames will be allowed, and no branches or outlets provided for other openings than those intended for fuel appliances, such as fireplaces, kitchens and laundries. Illuminating burners will positively not be allowed on fuel systems under any circumstances.

Rules Governing Size of Pipe.—To govern the size of piping to be used for fuel systems, the following rules should be followed:

Consider that each apparatus will be used to its maximum, and all pieces at one and the same time. Use as a basis for figuring pipe the following in ordinary residences and flats: Kitchen, 3 openings; laundry, 1 opening; each fireplace, 1 opening. An opening is figured to be ½ inch. For large buildings, consult the company for sizes of piping required. No fuel opening should be less than ½ inch. In figuring up the number of openings to be supplied use the following relations:

One ¾-inch opening=two ½-inch openings; one 1-inch opening = 4 ½-inch openings, or 2 ¾-inch openings; one 1¼-inch opening = 7 ½-inch openings, or 4 ¾-inch openings, or 2 1-inch openings; one 1½-inch opening = 12 ½-inch openings, or 6 ¾-inch openings, or 3 1-inch openings; one 2-inch opening = 20 ½-inch openings, or 10 ¾-inch openings, or 5 1-inch openings, or 3 1¼-inch openings, or 2 1½-inch openings.

If exact number of openings required is not given in the table, use the next larger size of pipe. Openings ½ inch in diameter will be allowed only when the maximum amount of gas to be used through them does not exceed 50 cubic feet per hour for each opening.

Length of Pipe.				Inches.
Do not run over	15	feet of	.....	½
" "	50	"	.....	¾
" "	80	"	.....	1
" "	100	"	.....	1¼
" "	150	"	.....	1½
" "	200	"	.....	2
" "	300	"	.....	2½
" "	400	"	.....	3
" "	500	"	.....	4

Residence or flat of 12 rooms or under: Kitchen openings, not less than 1 inch; laundry openings, not less than ½ inch; fireplace openings, not less than ½ inch.

Residences of flats of 13 rooms and over: Not less than 1 inch; not less than ¾ inch; not less than ½ inch.

All Ruud, Monarch and Columbia water heaters and heaters of this type should be provided with separate runs as provided in the following table:

Columbia.	Monarch.	Ruud.	No. of Openings.
No. 0	No. 0	No. 3	7
" 1	" 1	" 4	7
....	" 2	" 6	12
....	" 3	" 8	20

Hotels, boarding houses, restaurants, etc., should be considered special. The table is sufficient to cover almost any case of fuel piping sizes that may arise, but it is advisable for architects, builders, and others installing fuel piping systems to confer with the company's inspectors on all such installations in large buildings. Openings for fuel appliances should, as a rule, be 12 inches from the floor and project 1½ inches clear from the finished wall. All other rules for piping and inspecting not inconsistent with these, will be the same as for the illuminating system.

For Gas Engines.

Size of Engine.	No. of Openings.
1-horse power	4
2- " "	7
5- " "	12
7- " "	12
12- " "	20

Supply for gas engines must be separate, and an independent service will be required, unless a governing holder or other similar device, acceptable to the company, is used. It is advised that before proceeding with the installation of gas engines, or piping for same, consultation be had with gas company's inspector.

[Prepared for the JOURNAL, by "R."]

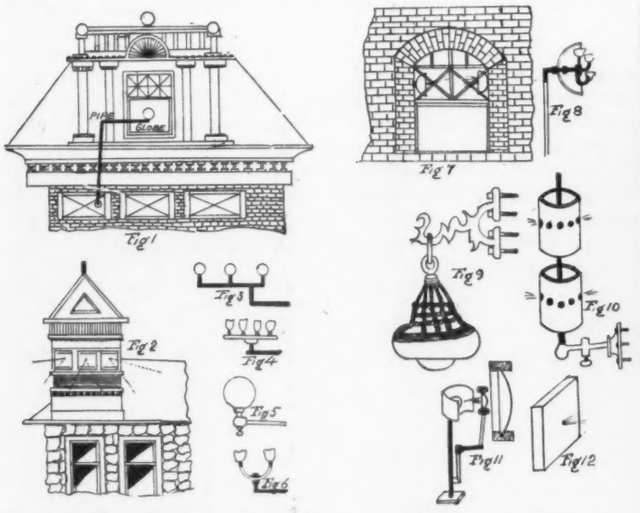
Lighted Upper Apartments.

Judging from what I am able to see, while traveling about the world, we are fast approaching an age of upper lighted apartments of dwelling houses. That is, the upper rooms or some upper works specially erected are furnished with the necessary brilliancy of light to demonstrate that ignited flames of some kind are prevailing. There are occupants of houses who just delight in having the attic, the top girl's room, the second cook's skyscraper, the tower or the belfry of the house, lighted up as if there were a festival in progress; and, when you come to think it over, it is not a very bad idea after all. There is hardly anything so pleasing to look upon as the evenly lighted home. It is a pleasant picture to look upon the house which has its upper lights as well as its lower lights burning. The home is made much more attractive to the people. The members of the family are more likely to remain in the brilliantly lighted home. The saloon, the places of amusement and the dancing halls do not economize in light in the least. They furnish light on the outside and in the top stories, they consume light in the halls and nooks and corners everywhere. The result is they are attractive and entertaining. You cannot expect people to stay at home evenings when the rooms and halls are dark or gloomy. Therefore, I believe we are getting into a time in history when light shall count for much in the career of man.

It has long since been proven that the beautiful home is the home which sheds forth its light from the windows over the scene of darkness for the returned traveller or the wayward son. The hostess can well entertain the guests when the lights glim forth from every point of the house, whereas if the place is poorly lighted the entire evening drags and something seems to be lacking. Consequently there has been a great demand in recent years for the introduction of lights for remote corners of houses. The towers have been entered and the apartments of the attic, where the owls formerly held sway, are now fitted with apparatus for diffusing light over the attractive scenery. The loving housewife delights in having the upper section of her home shining with the glow of colored lights. As a result of these systems of light-

ing unoccupied rooms in the upper portions of houses, we find that numbers of plans have been installed. At one home, where there were no other means of communicating a gas jet to an attic room, the gas pipe was run on the outside, having passed out through the window of the story below, entering the window above, as per the pipe line shown in diagram 1, but as a rule the pipes can be tapped on the inside and the line extended up through a floor to the attic room. I have seen rubber tubing used for this service, but it is better to have the gas man call and install a regulation ontfit of pipes and jets. Of course there are those who insist upon using the candle, the oil light or the portable gasoline or carbide gas outfits for lighting upper and distinct rooms. A great deal of annoyance is experienced when this is done.

The cat may upset the lamp; the candle may burn low and set the stand on fire, or something may happen to almost any description of portable light. Gas is the best for this service because it is safe. The upper rooms are not used very much in some homes, and you do not want to have to run up the stairs every hour of the evening to see if everything is right. Some put in electric lighting systems for the lights for the unused attic rooms, the towers and kindred apartments. There can hardly be anything more pleasing to look upon on a dark night than the red or other colored lights of the tower of the stable. Fig. 2 is a drawing of an installation of this order. The several lights are arranged so as to have one opposite each window, or else the lights can be clustered. Figs. 3, 4, 5 and 6 show some ways of planning the lamps for this purpose. In the event that acetylene gas is used, two or more of the little lava tips can be used to good advantage on one stem. It is a good idea to employ globes. The colors in the lights may be had by



using colored glass in the window sash or by using colored glass globes, and both systems are employed with equally effective results. In some of the towers of buildings are placed a system of signalling with the lights. This requires a shaft to be adjusted to the base lamp, which shaft reaches down into the lower rooms through the walls—the shaft is turned by a crank, and the different colors may be cast.

Fig. 7 illustrates a method of using a double reflector light, one reflector being fixed on either side of the window frame. The lights are cast one against the other and considerable brilliancy results. The bright, white light, made with air pressure on a tank containing gasoline, is sometimes used for the lighting of the upper apartments of dwellings. The jets for this light are as shown in Fig. 8. Occasionally the light is burned on a mantle, in which case extreme brilliancy follows; still the common gas jet fills the bill about as well as any kind of light. One may see some ornamental devices used for the lights of the upper windows, and one of this order is shown in Fig. 9. It is a large hanging basket affair with the lights arranged to burn inside.

Fig. 10 shows the metal tube system of adjusting the lights for service in an upper apartment where protection from the wind is needed. There are exterior stands and archways on roofs which may be lighted up. The protecting cylinders are of sheet metal and are set so as to cover the flame. The lights pass out through the openings in the cylinders. Then there are methods of developing the lights thus generated by means of magnifying lenses, arranged as in Fig. 11. This consists of putting a lens opposite the blaze, supporting it on the frame as shown. The light passes through the lens and is magnified.

Fig. 12 is a view of one of the large pieces of magnifying glass used for this service.

Light on Light in Faraway Lands.

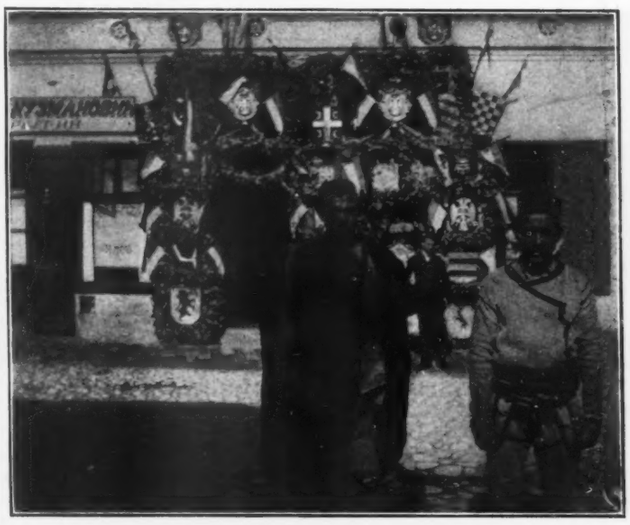
By Mr. Felix J. Koch.

American users of gas or electric lights little reckon the importance which candles and oil still play as illuminants in far southern Europe, the principalities along the Danube, and in the upper Balkan mountains. The candle, in fact, is paramount. Every house is illuminated, when at all, with candles. These are long, white affairs, invariably tied into bunches by their wicks, and so suspended from the roofs of the several bazaars. Bazaars of a sort in a given town are always clustered together, and prices and wages are always the same. Hence, whether you buy candles in one place or in another, there is no difference at all.

Candles, despite the great consumption, are relatively high in price. In every hotel there is a fresh candle in the "stick" awaiting the roomer's use. Let him have only as much light as this, however, he is charged for the whole of it on the bill. In consequence many travellers buy a dozen candles at the outset of a voyage, using these in place of those of the hosts.

In some of the larger Balkan cities, Bucarest and Belgrade, for example, electricity has been put into the hotels by way of illuminant, but here "lumiere" is invariably charged on the bill, whether used or not.

While great Greek or Bulgar orthodox churches are not conspicuous for their illumination, there are occasions when these fanes are exceptionally bright. It is quite the custom, especially in Servia, for the



Decorations in which Tapers are Thrust.

churches to maintain a booth out in the vestibule, where long, yellow, wax tapers, of the thinness of a joss stick, are sold, the proceeds going to the support of the church.

When one cannot stay to say many *pater nosters*, he buys of these tapers. Then inside the church, on the altar screen, or at the rear, there is a stand (diminutive telegraph poles made of zinc), to which these tapers are fastened by melting a bit of their own wax and permitted to burn. The sight, then, is not at all displeasing.

At funerals in Bulgaria, as the mourners gather in the church in advance of the arrival of the corpse, each and all are furnished with 2 or 3 tapers of this sort. These they light, one from another's, the first, however, having derived its light from a longer lighted taper in the hands of the dead.

At Plevnt, in Bulgaria, exists a custom whereby each and every mourner must shake hands with the corpse in its coffin. To heighten the terror of the scene, on the dead form Maltese crosses of these tapers are placed, the center of the cross being made by laying 2 tapers, one over another, upon a coin and then melting with wax. These ends well upturned are likewise lighted.

Furthermore, at funerals in all these Greek Church lands the corpse is preceded by two children bearing a mammoth pudding, to which all mourners are helped, and the pudding holds in its center another bunch of the bright burning tapers.

In the Balkans illuminants outside the city are almost unnecessary. The peasants, one and all, are exceedingly poor. Even meat is eaten

only on great feast days and at celebrations, because of the price. Artificial light is an unwonted extravagance.

The peasants rise at sun up. All day they work in the fields; at nightfall they return to supper. Then they are tired and ready for bed. The year round there is no variation in their labor or routines, hence there is nothing to talk about. The per cent. able to read is very small; the per cent. who can read, and have anything in which to indulge their knowledge, is even smaller. Result, wherefore there is no need of artificial light.

In Montenegro and some of the more southern of the States, petroleum has come into play as illuminant. In fact, riding into Cetinje, the

Arc Lamps on Belgrade Streets.

capital of Montenegro, from the gloom of the mountains, one never will forget the effect of the heavy, old-fashioned street lamps, projecting from one corner of every house on the main highway. The petroleum can, in fact, is met with all over the Balkans, being an actual medium of exchange, passing current as a piece of money. The reason for which is simple.

In the Balkan States, unless one lives beside a river, water is never free. On trains, in inns and the like, a glass of water is sold, just as soda water or beer is with us. Towns have their town fountains, of course, but unless one is willing to walk to these, as did Rebecca to the well, they must buy their water of the itinerant hawker. This, however, becomes expensive, so in every household it is the daily duty of some member thereof to go to town for the water, and the messenger makes use of the petroleum can, as the handiest allround vessel for such purpose.

In the caves of St. Canzian, on the east coast of the Adriatic, the flashlight has already made its way, though tourists desiring the use of one of these pay heavily for the privilege, at so much per centimeter of magnesium wire used. Originally the torch was employed in showing them through the caverns.

The general illuminating force of the Balkans, however, is still Old Sol, and the probably younger moon. Light is spared (when of artificial sorts), to the maximum, and while there are abundant streams to furnish water power for electric illuminant, their putting into service is undoubtedly still a matter of the far distant future.

Illuminating Power and Calorific Value.

By Mr. R. Nelson, in *Gas World*.

The trend of the present day in regard to illuminating power tests is in the direction of a standard burner that may be universally adapted to any gas, of whatever value, and varying within what may be termed practical limits, such burner to be used so as to obtain the maximum results from the gas under test, This seems to have been met by the "adjustable" Argand; and, judging from recent legislation, we may expect in the near future a universal testing clause, and one that will go to make the comparison of illuminating power tests of such a standard as has hitherto not been obtainable. It has been, and is yet, a very difficult thing to compare the tests of various companies' outputs, as what with different test burners and the modes of using these—not to mention the varying standard illuminants, etc.—the basis of comparison has been far from reaching anything near an ideal; and until such a clause has been drafted as will meet with the approval of all concerned in the construction and uses of the necessary apparatus, so long will the important consideration of "illumination" fall short of that high standard which should be the goal of all connected with the gas industry.

When such a position has been reached, and it seems to be within measurable distance, then there should be no hesitation in attaining what has been for years a desirable consummation. All authorities dealing in our commodity will no doubt keep this question to the front, so as to take advantage of the inclusion in their extended powers of any model clause that may have the approval of the governing bodies.

Comparative Tests with Different Argands.—Low illuminating power seems to be the order of the day; and if we are to have a gas of, say, 14-candle power as tested in an "adjustable" Argand, which, judging by recent reports appears to find most favor, then a short dissertation on how this is going to affect our "article," from the point of view of both producer and consumer, may be of interest to all concerned. It was with this object in view that the following series of tests with the present "specified" and an "adjustable" Argand were undertaken.

The first Argand was of the 15 hole variety, with a chimney 7 inches by 1¾ inches, the gas being burned at the 5 cubic feet rate, in accordance with the specified testing clause. Argand No. 2 was of the 24-hole type, with an adjustable air supply and a 6-inch chimney; the gas was burned to obtain the maximum illumination in all cases, and the resulting figures were corrected to the 5 cubic feet per hour rate.

It may be stated that in the majority of the cases under notice, the 5 cubic feet per hour rate was adhered to with the "adjustable" Argand tests, as this was found to give maximum results, especially with gases of the lower illuminating powers; and with this particular burner it was not necessary to reduce the rate of consumption until over 15-candle power gas was being used, the results as shown being fairly even, thus proving that the air supply was under efficient control within very wide limits.

The following table gives the comparative figures obtained with the two burners previously mentioned. The gas under observation was neither "diluted" nor "enriched" at the time of testing, but was obtained under the usual working conditions of carbonization.

Table of Illuminating Powers, Using Argands Nos. 1 and 2.

Gas Under Test.	Illuminating Power with Argand No. 1.	Illuminating Power with Argand No. 2.	Candles per Cubic Foot. No. 1.	Candles per Cubic Foot. No. 2.
A.....	11.50	15.26	2.30	3.05
B.....	11.70	15.71	2.34	3.14
C.....	12.08	16.15	2.42	3.23
D.....	12.36	16.59	2.47	3 32
E.....	12.96	17.18	2.59	3.44
F.....	13.60	17.43	2.72	3.49
G.....	14 27	17.85	2.85	3.57
H.....	15.10	18.75	3.02	3.75
I.....	15.26	18.54	3.05	3.71

In considering the above table it will be found that the increase in illuminating power in using the No. 2 Argand over the results obtained by the No. 1 Argand is as follows:

				Per Cent.
A	11.50-candle power by No. 1 the increase (No. 2)		=	32.7
C	12.08	"	"	33.7
F	13.60	"	"	28.16
H	15.10	"	"	24.17

The Commercial Value.—Thus, in the figures obtained during the present tests, the higher increased values are shown in the lower illuminating powers, a proportionate reduction taking place as the illuminating value increases. The writer does not put this forward as showing what may result in the use of any "adjustable" Argand, but simply gives the figures that have, up to the time of writing, been obtained with the particular burners experimented with; and it may be (and there is, perhaps, every reason to believe it will be so) that a burner will be devised that will give the same proportionrte increase to all gases of varying values within practical limits. What, then, would be the position of a company after having obtained an amended testing clause with the inclusion of an "adjustable" Argand?

To cite a hypothetical case based on the preceding figures, suppose the illuminating power to remain at, say, 14 candles, and the new test burner to be "adjustable," then, instead of the producer supplying gas of 14-candle power—as judged from the point of view of the consumer—he would be empowered to supply gas of about 10 candles, as compared with what was to be supplied under the old act, always bearing in mind that the customer will examine the article he purchases from the one standpoint.

This would be a somewhat drastic change to make within any short time, and the writer does not intend to say how it might be done to the satisfaction of all concerned. Various local and other conditions would, of necessity, have to be seriously considered, and it would remain with the individual parties to give judgment thereon.

These thoughts are simply given utterance to, seeing that in some (perhaps rare) cases the buyer does not grasp the value of his gas supply as he does that of other goods which he must, of necessity, purchase; "bad gas" being only too well known to the average gas manager as the plea for all faults.

Calorific Value Tests.—As the calorific value of gas is now being looked upon as of greater importance than illuminating power, it is interesting to compare the difference in this respect in the case of the gas under notice.

The following table gives the various calorific values of the gases experimented upon as ascertained in a Boys' calorimeter:

Gas.	Net Calorific Value, B.T.U. per Cubic Foot.
A	502.40
B	518.43
C	515.71
D	525.40
E	530.32
F	537.41
G	542.18
H	554.52
I	554.19

Thus the gas under test marked G, having an illuminating power of 14.27 candles, has a calorific value of 542.18 B.T.U., while a gas of 10 candles would have an approximate heating value of, say, 450 B.T.U.. or a reduction in illuminating value of 29.92 per cent., but of only 17 per cent. in calorific value. It is evident, therefore, that, judging from present-day conditions of gas consumption—*i. e.*, incandescent lighting and heating generally—the ratio of reduction that would obtain under our hypothetical case would not be so serious as might at first be anticipated. It remains with the industry at large to educate their customers up to this point, so that they may see for themselves the merits of any proposed alteration.

The necessity for standard testing clauses, whether of calorific or illuminating values, is of the utmost importance, and would go far to convert what is sometimes very much like chaos into cosmos.

Some Points on Illuminating Engineering for the Small Central Station.

[Read by Mr. J. R. CRAVATH, at the last meeting of the Northwestern Electrical Association.]

In a short convention paper of this kind it is manifestly impossible to take up thoroughly even one small branch of illuminating engineering. All that I can, therefore, hope to do in this paper will be to give a few hints of practical value to the central station man as to some of the things to be aimed at and avoided in securing good illuminating results for customers. The awakening to the importance of illuminating engineering during the past 18 months has been truly remarkable, and has been both a surprise and a gratification to those of us who have made this subject a hobby for several years past. Of all those who should rightly take an interest in securing better illumination for the money expended, central station men have far outnumbered any other class. While this fact might seem peculiar to the general public, which erroneously supposes that the central station companies want to get the biggest revenue possible for the least service rendered, it does not seem at all peculiar to those familiar with the broad-minded and progressive men in the central station industry. It is hardly necessary to say that it is recognized by all progressive companies that the securing of better illuminating results for a given expenditure is one of the best means of stimulating the central station business and of meeting the competition of other illuminants.

We are on the eve of a great change in the electric lighting industry. The incandescent lamp in its various new forms is being so enormously increased in efficiency that it promises not only to displace all other electric illuminants for indoor work, but to drive out of use many of the common competing illuminants such as gas and gasoline. Of equal importance with the introduction of higher efficiency lamps is the progress that is being made in the art of getting the most effective illumination from whatever lamps are used.

The two principal points to be borne in mind by those wishing to design good illumination are: First, the blinding effect of lamps placed in the ordinary line of vision, and second, the importance of directing most of the rays of light where they are needed instead of letting them escape in directions where they are useless. The bad effect both on the eyes and on the apparent illumination of a room, when lamps are placed where the eye cannot escape them is probably too well understood by this time to need further explanation. At least, if it is not understood, only a little experiment is needed to make it clear. In connection with the practical application of this point, the problems are confined to locating the lamps so that they will not blind the observers or to covering them with diffusing shades and globes.

The second point, that of directing most of the light in useful directions, makes it necessary to have information at hand on the distribution of light about the different illuminants under consideration when used with the reflectors, shades or globes with which they may be equipped. Here one deals no longer with general principles, but with engineering data on the various appliances. Previous to 15 months ago exact information on this point was very meager. It is now obtainable in much larger quantities than it was then and within the next few months there will be further important additions to the available literature on the subject. Manufacturers of lamps and glassware are beginning to appreciate the fact that they must furnish photometric curves from some reliable laboratory showing the light distribution about lamps with the various appliances used therewith, if they are to sell their goods to people who are particular as to what illuminating results they get and who take the performance as well as the general appearance of the device into consideration when purchasing.

The question of the performance of different specific reflectors is one which cannot very well be taken up in a convention paper of this kind, as it is one which consumes time and requires careful study. Anyone designing illuminations must be very familiar with what is obtainable on the market in the way of appliances for changing the natural distribution of light about a lamp. A few general observations are not out of place here, however.

There is as much difference between the different kinds of glassware that may be placed over an incandescent lamp as there is between the performance of a lawn sprinkler and a fire hose nozzle. The performance of a bare incandescent lamp or a lamp placed within an opal, opaline, frosted or pressed glass inclosing globe may be compared to the lawn sprinkler; that is, the light is thrown out in all directions, more being thrown horizontally than any other way. The performance of some of the concentrating conical reflectors, either of the opal, prismatic or mirror types, can be compared to the concentrated stream of water from a fire hose nozzle. Each form of light distribution manifestly has its proper place. I am frequently asked what I think of some kind or make of reflector or globe. The answer is nearly always the same: "An excellent thing in its proper place." To be sure, there are a few for which the proper place is the scrap pile. Personally, I would place in this latter classification all opaline inclosing glass globes, which, while absorbing considerable light, nevertheless are not sufficiently dense to prevent the lamp filaments showing through with a dull, sickly hue like a red-hot hair pin. They are certainly not ornamental and accomplish only imperfectly the object of softening the light. A dense opal globe is one of the best diffusers, but its absorption of light is high. Frosted or sand blasted and holophane inclosing globes give excellent diffusion with the lowest possible absorption.

The most generally useful reflectors on the market at the present time are those of opal glass and those of prismatic glass. Opal glass has been known and used as a reflector for many years. Prismatic reflectors have come into use more recently. These two types of reflectors are most generally useful because with them it is possible to throw a certain proportion of the light in the directions where it is most needed, and at the same time, some light passes through to illuminate the upper part of the room. It is possible to obtain very similar light distribution effects with opal and prismatic reflectors. At present writing there is this difference, however, that prismatic reflectors have been made in a greater variety of forms and that, therefore, one can obtain a greater variety of light distribution effects with prismatic than with opal glassware. Opal glassware being an unpatented trade article, there seems not to be the incentive to manufacturers to produce it in shapes scientifically correct that there would be were some one manufacturer putting it forward in competition. The relative appearance of prismatic and opal reflectors is a matter of personal taste which it is useless to discuss here.

Among the opaque reflectors there are several mirrored types and those of metal either coated or uncoated on the inside. The use of these is confined to places where it is not necessary or desirable to have some light shine through the reflector. A mirrored reflector for most prac-

tical uses must either have a corrugated surface or be equipped with a frosted bulb lamp to avoid streaked light. Of the metal reflectors aluminum with frosted finish inside is the most generally useful, as it is easily cleaned inside with sandpaper at any time and the frosted finish makes unnecessary the use of a frosted bulb lamp.

The following are a few practical points of policy and management that can well be observed by central station companies desiring to promote the more efficient use of incandescent lamps on their circuits:

Encourage the installation of lamp sockets pointing straight down, both for chandeliers in residence lighting in the majority of residences and for store lighting. It is frequently difficult to produce good illuminating results with lamp sockets at an angle. With diffusing reflectors too much light will be thrown up toward the ceiling and with concentrating reflectors concentrated beams of light will be thrown out at the various angles at which the lamps point, causing an unpleasantly uneven distribution. In either case the lamp filaments will be visible to anyone within range of the reflector, unless shortlived frosted bulb lamps are used. Furthermore, lamp sockets come to pieces and shade holders sag under the weight of shades at an angle, producing a slovenly appearance. If your company does wiring and sells fixtures, put this rule into practical operation at once. It costs no more to make chandeliers with pendant sockets than any other way.

Equip every chandelier which goes into the general living room of an ordinary residence with what is frequently termed by fixture makers a "bottom tap," that is, a socket at the bottom of the main stem. There can be used on this bottom tap a reflector which will concentrate light around under the chandelier for reading purposes, leaving the lamps on the fixture arms to be equipped with glassware for the general distribution of light in every direction throughout the room on special occasions.

Do not encourage the erroneous idea that the majority of fancy electric portable lamps are satisfactory reading lamps. This erroneous idea has probably done the electric lighting industry as much damage in residence lighting as any other one mistake in illuminating design. A portable stand lamp with a very deep opal dome shade will give a fairly satisfactory reading light immediately around a small table. Such a dome is not specially ornamental and a light much more satisfactory both for reading and for general illumination can be provided by the proper opal or prismatic reflector placed on the bottom tap of the chandelier, assuming that the readers sit under the chandelier. Furthermore, this chandelier bottom tap lends itself readily to the attachment of a short drop cord on which is arranged a concentrating reflector which can be used for work requiring very intense illumination.

If possible, do not allow any art glass domes to be installed in customers' dining rooms or elsewhere, with the old-fashioned arrangement of a cluster of lamp sockets in the dome pointed at various angles. The lighting within the dome should be done from one socket pointing straight down in which a lamp of any desired candle power can be used. Over this lamp should be some type of reflector which gives a photometric curve with "ears" on it; that is, it should give more light at an angle of 40° from the vertical than directly underneath, so that the table top will be evenly and efficiently illuminated. Above this one lighting socket in the art glass dome there may be a couple of other sockets for the attachment of electric chafing dishes, etc., but the practice is not at all to be recommended, a new house should always be provided with a separate heating circuit and a floor outlet for the easy connection of heating devices to be used on the dining room table.

Discourage as far as possible the use of glassware which neither accomplishes the diffusion and softening of the light nor the directing of its rays at useful angles. Some central station companies do not have such control over what is placed on their lines, but in other cases they have almost entire control of the matter. The glassware and fixtures that will be used on new jobs in a town will depend almost entirely on what the company or contractor keeps in stock. It has been observed that a great many of the smaller companies are loaded up with a lot of glassware and fixtures which are not at all likely to be conducive to the satisfactory use of electric light. The average customer will take an inefficient device because he can get it at once, rather than wait for something better to be ordered from a distant supply house. To him one is just about as good as another.

Discourage the use of large chandeliers with small lamps, except possible as a decorative feature. The new large high efficiency units placed either alone or in clusters of two or three will give much better results.

Except where the color of the arc lamp is desired, incandescent clusters using high efficiency lamps of the same wattage as the arc will give better illuminating results than the ordinary arc, and will be free from the great variations common with arc lamps.

Do not use the new high efficiency incandescent lamps of 100 watts and over without having the bulbs two-thirds frosted for the concentrating and distributing reflectors and frosted on the tip with the new bowl reflectors. These lamp filaments are too large and the light too intense to be exposed, without some method of diffusion for the protection of the eye.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE Bartlett-Hayward Company, of Baltimore, Md., has been awarded a contract for the construction of a 5-lift storage holder on the Williamsburgh branch of the Brooklyn Union Gas Company. Its rated capacity is 5,000,000 cubic feet, and it is to rest in a steel tank.

AFTER much contention the deadlock in the Phillipsburg (N. J.) Town Council over the matter of the public lighting of that place, in so far as electric arcs is concerned, has been ended. The contract goes to the Easton (Pa.) Gas and Electric Company at its bid of $65 per arc per annum. The life of the contract is 5 years.

MR. EDWARD M. WALKER'S resignation as General Manager of the Bristol (Tenn.) Gas and Electric Company has been accepted.

THE new course in Gas Engineering, Mechanics' Institute, Rochester, N. Y., is in good working order, and is attracting considerable attention.

THE New York Commission of Gas and Electricity has denied the application under which it was asked that the trading of the Watertown Gas Light Company and of the Watertown Electric Company might be consolidated. The Commission having examined both plants, and analyzed the conditions under which the companies were carrying on their busineess, decided it would be against public interest to permit the consolidation of the gas and electric lighting supply of the city. In fact, the Commission in substance said that such consolidation would place the power in the hands of the Company, after consolidation, to unduly advance the "interest" of one kind of lighting at the expense of the other, and often force consumers to accept the product of one of the companies when desiring another—whatever that may mean.

JUDGE TAYLOR has ordered Mr. John McSweeney, as Receiver of the properties of the Wooster (O.) Gas Light Company, to sell the same at public auction some time during the current month.

MR W. F. DOELKER, who has represented the Child-Hulswitt interests in Mattoon, Ills., since the latter were acquired by them, has been appointed to look up their business in Cadillac, Mich. He takes charge there the 15th inst.

THE residents of Weatherford, Tex., are loud in their acclaim of the service they are getting from the owners of the Weatherford Gas Light, Heat and Power Company. Gas was turned on for the first time something over a fortnight ago.

MR. FREDERIC EGNER has disposed of his realty in the St. Louis park plot owned by him, close to Norfolk, Va., to the Norfolk and Southern Realty Company. He is to be congratulated on his perspicacity, for when he went to Norfolk the second time he simply secured for a comparatively small sum a plot of valuable water front that the real estate experts of Norfolk and other districts apparently had overlooked. He deserves his good fortune, and we hope he will long live to enjoy its returns.

AT the annual meeting of the Alpena (Mich.) Gas Light and Fuel Company, the Directors elected were: Messrs. E. M. Deane, Dwight Smith, F. G. Deane, G. W. Browning, E. P. Merrick, Geo. Metz, H. W. Wales, Jas. E. Furman and W. W. Hunt—Mr. Hunt replaces Mr. James Trimble.

THE Second Annual Report of the New York Commission of Gas and Electricity has been made to the Legislature, and it covers matters that came within its jurisdiction during the twelvemonth ended December 31st last. Perhaps the most important recommendations it contains have to do with questions of procedure, and the laterals. As the statute now stands, in the instance of complaints, these can be made t›

the proper municipal authorities, or by 100 or more consumers of gas or electricity in the territory of the corporation complained of. The Commission recommends their amendment so that complaint may be made by 25 customers in the territory served where it contains less than 1,000 population, by 50 customers where the population is between 1,000 and 5,000, by 75 where the population is between 5,000 and 10,000, and by 100 in all other places. The amendment would seem to aid greatly in the multiplication of frivolous complaints. The Commission further recommends an amendment which will require a company incorporated before the law went into effect to obtain the consent of the Commission before exercising its powers under a franchise hereafter obtained from the local authorities. Such companies are now free to invade the territory of established companies without first obtaining this consent. Further recommendations are: That authority be given to the Commission to revoke all certificates of authority to transact business where the construction of the plant in question is not begun in good faith within a certain period from the date of issuing such a certificate; and that municipal gas or electric plants should be compelled to make annual reports to the Commission. The Commission calls attention to the fact that no provision is made, upon the application of a company, for a revision of prices after the expiration of 3 years for which the price is fixed. The Commission considers it to be only fair that a company should have the same right as the consumers to apply for revision of price fixed by it, as changing conditions might increase the cost of production and distribution. The report shows that there is a total of 426 corporations, municipalities and individuals furnishing gas or electricity for light, heat or power in the State coming under the supervision of the commission. The capitalization of these companies aggregates $456,000,000, and the gross income from operation approximates $75,000,000 per annum. During the year ended Dec. 31, 1906, the Commission had before it for consideration 74 applications, upon all but 3 of which public hearings were had. During the year the applications of 29 companies for certificates of authority for consent to issue stocks or bonds and for consent to increase issues of stock or bonds were passed upon by the Commission. The capitalization asked for aggregated $9,492,000, while the amount allowed by the Commission was $6,837,000, a reduction of $2,655,000, or approximately 28 per cent. In reducing the amount of stock and bonds applied for, the Commission followed its policy of requiring each company applying for consent to make such issues to furnish the Commission with a statement in detail as to the purposes for which the proposed issue was to be used. In no case did the Commission allow an issue except for actual improvements and extensions to plant. During the year the Commission received complaints as to the price and quality of gas or electricity from Albany, Buffalo, Rochester, Watertown, Mount Vernon and Nyack, and it is now conducting an investigation into each of these cases. Complaints were filed with the Commission prior to January 1, 1906, against the Consolidated Gas Co., of New York and its subsidiary Companies; the Brooklyn Union Gas, the Syracuse Lighting, the Plattsburgh Light, Heat and Power, the Lozier Light, Heat and Power, and the Auburn Gas Companies. The report reviews the results accomplished by an investigation of the complaints. During the year reductions in the price of gas were made in 14 cities and towns of the State. Reductions in the price of electricity also were made during the year in more than 30 cities and towns. The amount of gas sold to consumers and for public lighting during the year was 39,858,755,381 cubic feet as against 37,914,016,000 cubic feet for the preceding year, an increase of about 5 per cent. The report shows that although gas for illuminating purposes has been supplied in this State since 1823, no regular or systematic inspection or examination has been made of the purity and illuminating value of the product supplied, except in the city of New York, until during the past year when the Commission established a department for such purposes. Tests have already been made in practically every section of the State and the results showed the candle power of the gas furnished to be very low. An order has been issued by the Commission compelling all companies furnishing 15,000,000 or more cubic feet of gas annually to install an improved photometer for use in making frequent tests of candle power. During the year 350,858 meters were inspected and sealed by the State Inspector. Of this number 5,548 were private meters, 1,446 of which were found to have run fast, 883 slow and 3,219 correctly. During the year the Commission received reports of 540 accidents, of which 439 were minor, 101 were major, and 28 were fatal. The Commission has notified the various companies that it has under consideration a preparation of a uniform system of bookkeeping, and has invited them to furnish a classification of accounts employed and to offer suggestions. Many companies have responded, and with this as a basis, there has been outlined for adoption a system of accounting which is adopted to small as well as large companies.

THE Massachusetts Board of Gas and Electric Light Commissioners has authorized the Quincy Electric Light and Power Company to issue $50,000 additional capital stock, and it has also authorized and approved the contract that has been entered into between the Boston Consolidated Gas Company and the New England Gas and Coke Company, under which the latter is to supply certain quantities of gas to the former for a period of 2 years, beginning December 1, 1907. The Commission fixes the maximum purchase rate at 30 cents per 1,000 cubic feet, the gas to be of 18-candle power, and to contain no ingreients in percentage prescribed by the State statute applying. In the matter of purification it is specified that if the cost of same to the wholesaler shall exceed 1 cent per 1,000, the retailer shall pay for the excess purifying cost. All measurements and power test are to be taken after the gas is purified, and the price is to be reduced 2 cents per 1,000 for each candle power shown below 18. Under the contract the Boston Consolidated Company must take 2,500,000 cubic feet of gas each 24 hours, and should the quantity taken not reach that specified in the figure, the Boston Consolidated Company shall pay to the Gas and Coke Company at the rate of 15 cents per 1,000 for the shortage.

THE Boise (Idaho) Gas Light Company recently issued the appended statement, the concession to date from January 1st: "The following discounts will be allowed on bills for gas consumed, when such bills are paid on or before the 10th day of the month next following service. First 2,000 cubic feet, 25 cents per 1,000; all over 2,000 cubic feet, 50 cents per 1,000, reducing the net price of gas used in excess of 2,000 cubic feet in any 1 month. Bills will be rendered at the heretofore gross rate of $2 per 1,000 cubic feet.

AT the annual meeting of the Boise Gas Light Company, the officers elected were: Directors, J. P. M. Richards, A. Ross, Charles Theis, W. N. Donaldson and C. D. Lamson; President, A. Ross; Vice-President, Charles Theis; Secretary and Treasurer, W. N. Donaldson; Manager, C. D. Lamson.

THE shareholders of the Winsted (Conn.) Gas Company, have assented to an increase in the capital to $175,000.

HERE is a nut for the advocates of municipal ownership to crack and apply to quiet consideration the usefulness of the meat extracted—the figures show the strides made in the sales of gas in Philadelphia since the U. G. I. Company leased the Philadelphia municipal gas plant:

Year.	Cubic Feet Gas Sold.	Gross Receipts.	Increase.
1906	7,061,291,430	$6,355,162	$224,098
1905	6,812,298,960	6,131,009	222,667
1904	6,564,891,970	5,908,402	90,255
1903	6,486,829,960	5,838,147	957,330
1902	5,423,129,500	4,880,817	1,100,535
1901	4,200,313,150	3,780,282	259,842
1900	3,911,599,400	3,500,440	312,111
1899	3,564,810,610	3,208,319	479,463
1898	8,032,073,810	2,728,866	.....

PRESIDENT KENAN, of the Union Gas and Electric Company, of Cincinnati, during the period of stress caused in that city by the flooded condition of the river, gave free of charge to the Flood Relief Work Committee all the gas and electric service needed in the carrying on of the relief work.

THE General Gas Light Company, of Kalamazoo, Mich., is making extensive additions to its factories.

THE McKinney bill, to abolish the office of State Gas Inspector for Indiana, has been defeated.

THE Citizens Gas Company, of Jacksonville, Fla., has called in for payment all of its bonds bearing date of December 31, 1900. The bonds are redeemable at the office of the Columbia Trust Company, of Middletown, Conn., or at the office of the National Bank of North America, New York. Interest on the bonds ceased the 1st inst.

MR. WILLIAM RAMSEY has been appointed Gas Inspector for Allegheny county, Pa. He was originally named to the position by ex-Governor Pennypacker in 1904.

THE AMERICAN GAS LIGHT JOURNAL

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NOTIFICATION RESPECTING ADVERTISING.

Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:

New York—American News Co., 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, FEBRUARY 4, 1907.

The Market for Gas Securities.

Depression ruled in the general share list last week, and with the rest down went Consolidated. Why a stock like it should follow the general vagaries of the market passes our understanding. The Company's business is simply amazing, and it looks to us beyond question that at the quoted price no large investor could pick out anything better. It opened today (Friday) at 133½ to 135.

Brooklyn Union holds its recent slight gain. The figures respecting it are 110 to 120. Peoples, of Chicago, is back again to a 6 per cent. basis. Massachusetts Gas Companies goes along smoothly. Our recent remarks regarding it still hold good. It will beat 80 before the end of the year. Bay State gas is at ½ to ¾, some activity having manifested itself therein in the instance of the settlement between the Receiver and H. H. Rogers.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

FEBRUARY 4.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	134½	135
Central Union Gas Co.—				
1st 5's, due 1972, J. & J.	3,000,000	1,000	101	104
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	..	105
Mutual	3,500,000	100	190	225
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000 000	1,000	98½	100
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	37	43
1st Mtg. Gold Bds. 5 p.ct.	1,000,000	..	98	104
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	101	103
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	108	111
Con 5's, due 1945, J. & J.	1,500,000	..	104	110
Standard	5,000,000	100	140	160
Preferred	5,000,000	100	155	175
1st Mtg. 5's, due 1930, M. & N	1,500,000	1,000	104	108
The Brooklyn Union	15,000,000	1,000	110	120
1st Con. 5's, due 1948, M. & N	15,000,000		107	..
Yonkers	299,650	500	130	..
Out-of-Town Companies.				
Bay State	50,000,000	50	½	¾
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	..	65
" 1st Mtg. 5's	509,000	1,000	95	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000.000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	9	10
" " Bonds, 5's	5,250,000	1,000	75	80
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	106¾
Cincinnati Gas and Electric Co.	29,500,000	100	99½	100
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	90	..
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	..	95
Preferred	3,096,500	100	107½	108
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	.	90
Mortgage, 6's	3,600,000	..	..	115
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	980,000	1,000	92	95
Bonds	75,000	..	..	100
Detroit City Gas Co	5,000,000	50	..	50
" Prior Lien 5's	4,618,000	1,000	..	98
Detroit Gas Co., 5's	381,000	1,000	75	80
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,600	..	39	40
Fort Wayne	2,000,000	..	..	..
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,925,500	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	..	110	112
Bonds, 5's	10,500,000	..	107½	108½
Indianapolis	2,000,000	..	60	70
" Bonds, 5's	2,650,000	..	104½	105
Jackson Gas Co	250,000	50	82	..
" 1st Mtg. 5's	290,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	..	05
Preferred	2,500,000	100	95	110
Bonds	10,000,000	1,000	104	104½
Lafayette Gas Co., Ind.	1,000,000	100	..	60
Bonds	1,000,006	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	106	108½
" 6 per cent. scrip, due 1910	100,000	25	85	87
Massachusetts Gas Companies of Boston	25,000,000	100	64½	65
Preferred	25,000,000	100	85	85½
Montreal, Canada	2,000,000	100	218	218¾
Nashville Gas Lt. Co	1,000,000	100	110	..
Newark, N. J., Con. Gas Co.	6,000,000	..	56	58
Bonds, 6's	6,000,000	..	137	138
New Haven	2.000,000	25	200	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	96	96¼
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
" 2d "	2,500,000	1,000	104	..
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	104½	105¼
San Francisco, Cal.	16,800,000	100	..	..
St. Joseph Gas Co. 1st Mtg. 5's	751,000	1,000	92	..
St. Paul Gas Light Co	1,500,000	100	45	47
1st Mortgage 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	98¼	..
Syracuse, N. Y.	1,975,000	100	50	55
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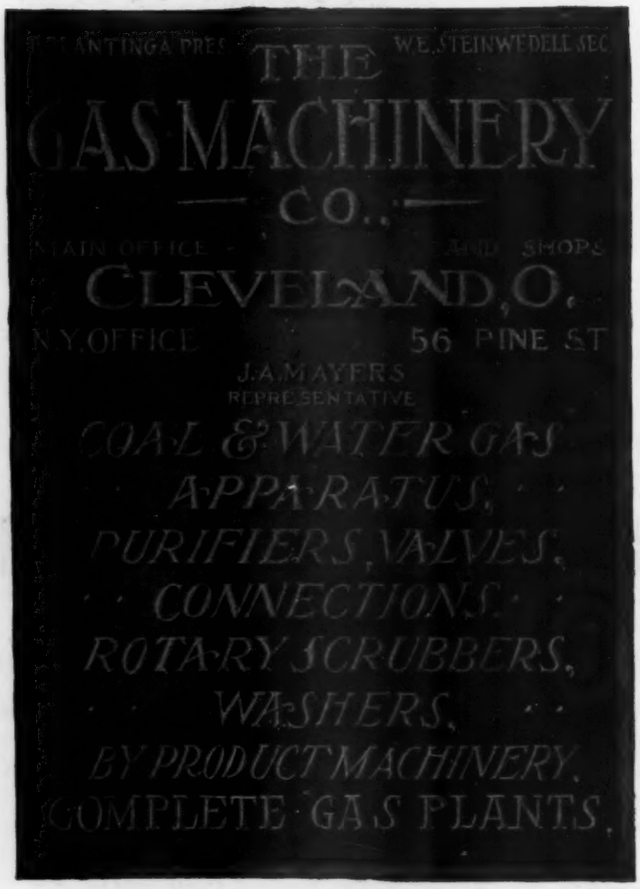
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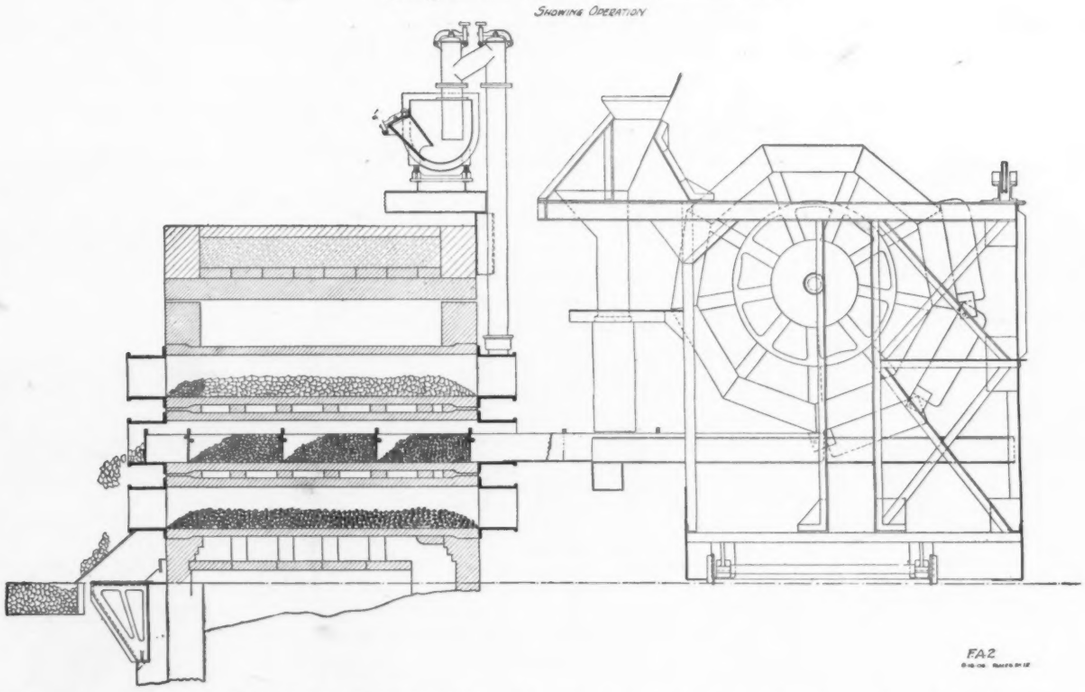

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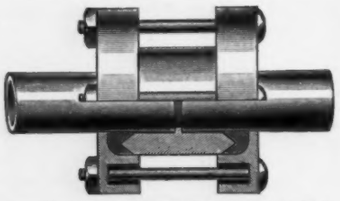
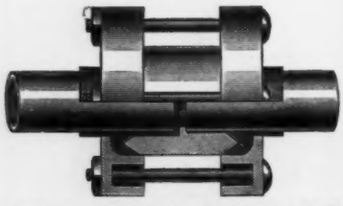
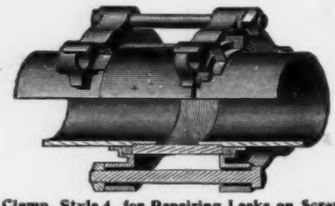
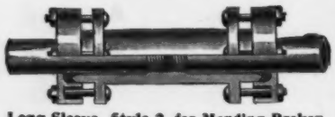

Regular Coupling, Style 1, for Plain End Wrought Iron Pipe.


Insulating Coupling, Style 5, for Plain End Wrought Iron Pipe.


Clamp, Style 4, for Repairing Leaks on Screw Collar.


Long Sleeve, Style 2, for Mending Broken Lines.

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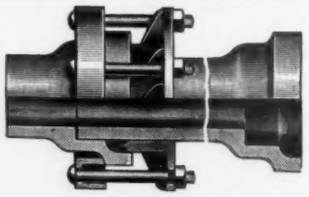
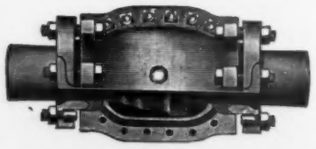
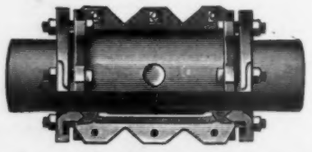
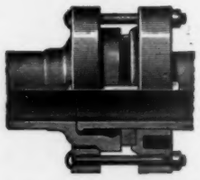

Coupling, Style 9, for Special Style Cast Iron Pipe.


Split Sleeve for Repairing Broken Bell on Cast Iron Pipe.


Split Sleeve for Repairing Broken or Cracked Cast Iron Pipe.


Clamp, Style 4½, for Repairing Leaky Lead or Cement Joints in Cast Iron Pipe.

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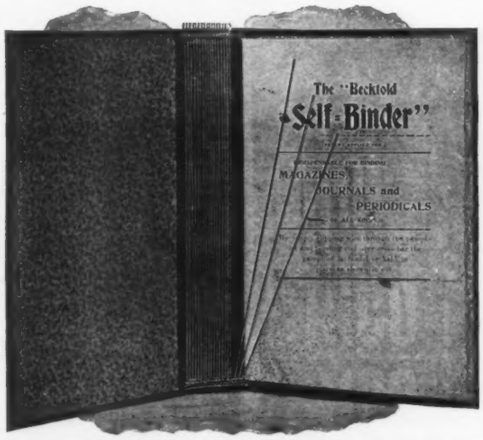

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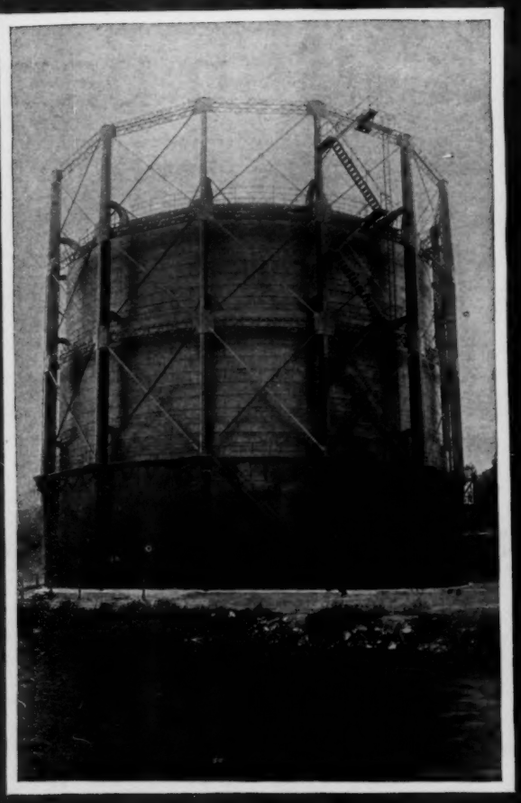

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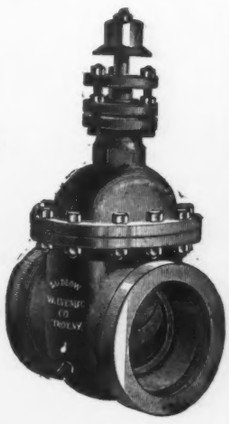

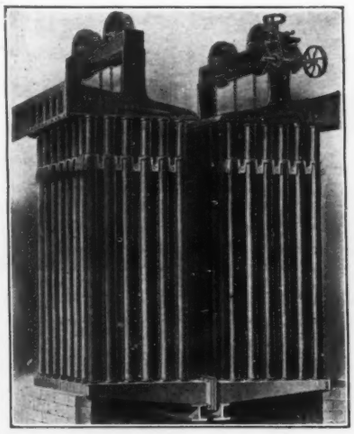

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Contact 6	24.00	¾ "	3	29½ "	12 "	60 "
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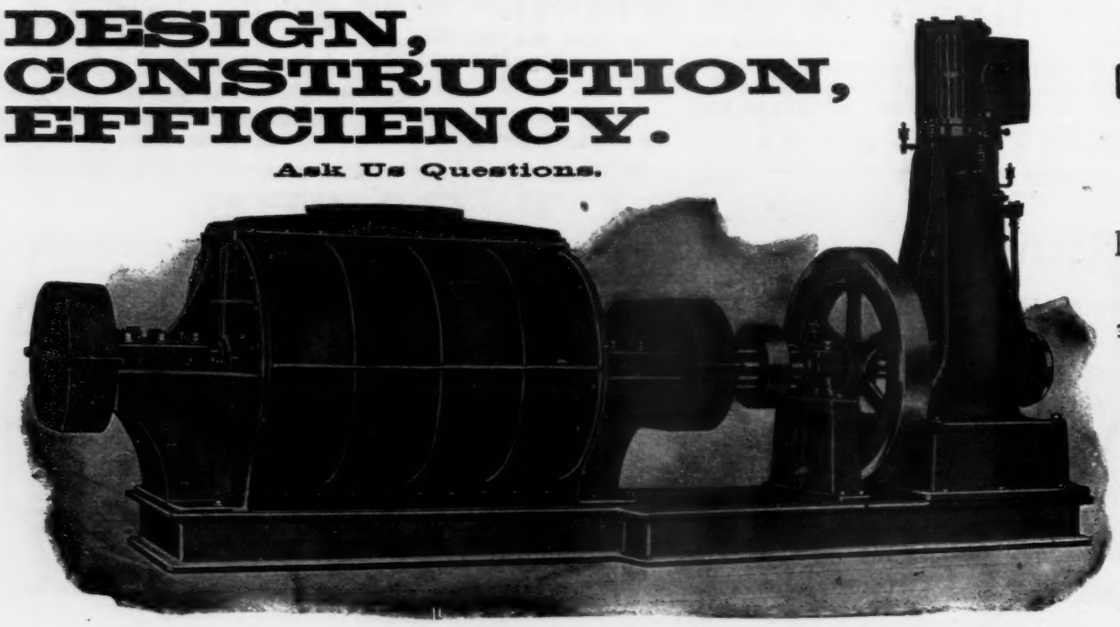

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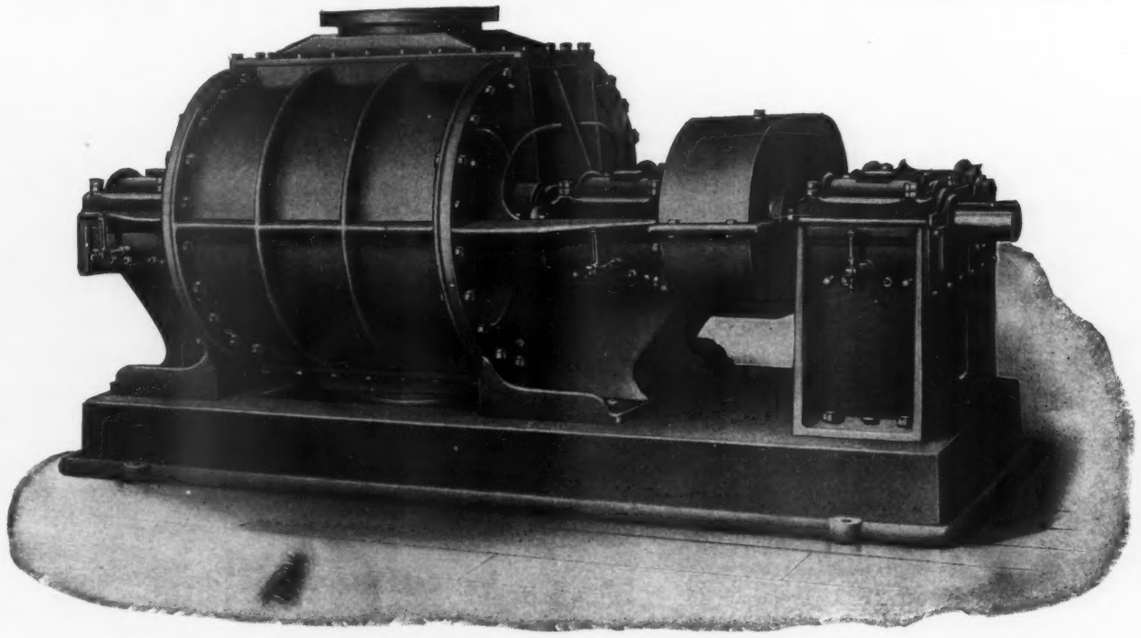

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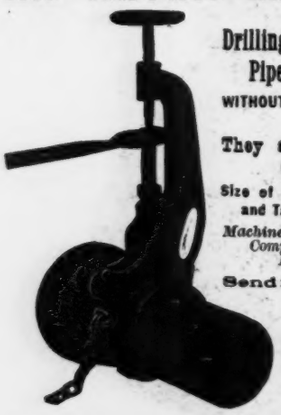

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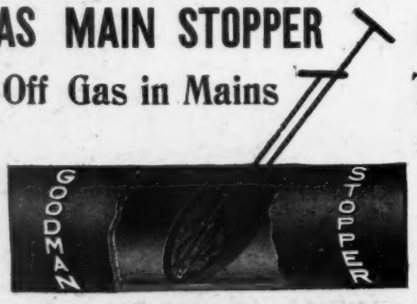

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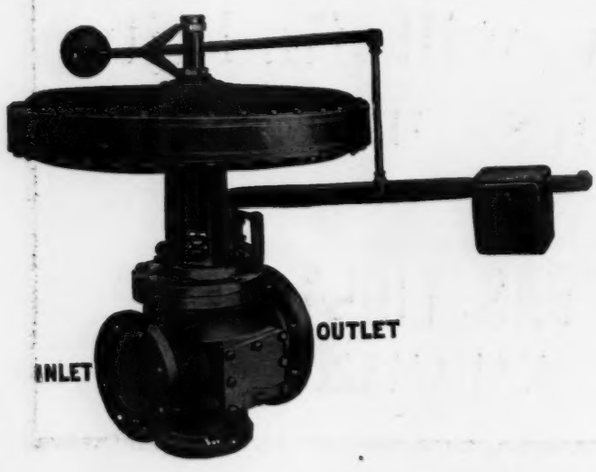

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PUBLIC LIGHTING TABLE.

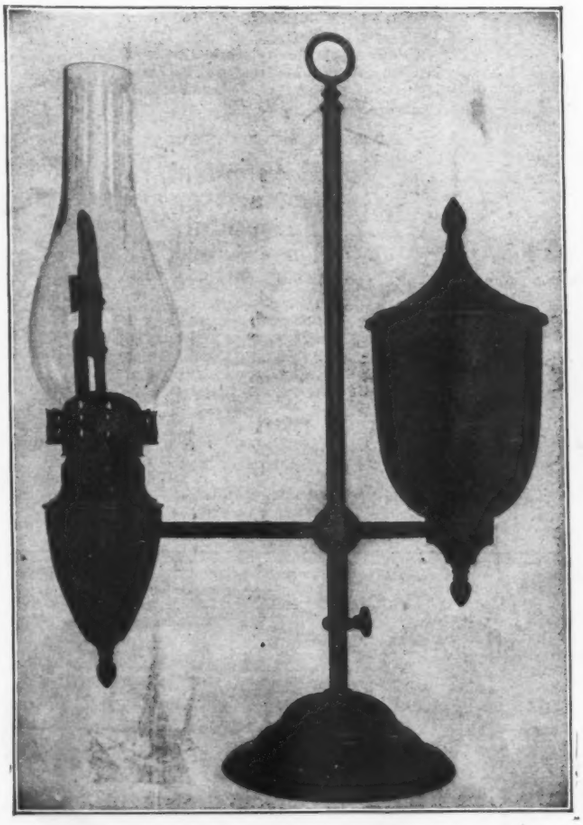
FEBRUARY, 1907.

Day of Week.	Table No. 1. FOLLOWING THE MOON. Date.	Light.	Extinguish.
Fri.	1	5.50 PM	9.30 PM
Sat.	2	5.50	10.30
Sun.	3	5.50	11.40
Mon.	4	5.50	12.50 AM
Tue.	5	5.50 LQ	1.50
Wed.	6	5.50	3.00
Thu.	7	5.50	4.10
Fri.	8	5.50	5.20
Sat.	9	5.50	6.00
Sun	10	6.00	6.00
Mon.	11	6.00	6.00
Tue.	12	6.00 NM	6.00
Wed.	13	6.00	6.00
Thu.	14	6.00	6.00
Fri.	15	6.00	6.00
Sat.	16	6.00	6.00
Sun.	17	10.00	5.50
Mon.	18	11.00	5.50
Tue.	19	12.00 FQ	5.50
Wed.	20	12.50 AM	5.50
Thu.	21	1.50	5.50
Fri.	22	2.40	5.50
Sat.	23	3.30	5.50
Sun.	24	4.10	5.40
Mon.	25	4.50	5.40
Tue.	26	No L.	No L.
Wed.	27	No L FM	No L.
Thu.	28	No L.	No L.

TOTAL HOURS DURING 1907.

By Table No. 1.

	Hrs.Min.
January	211.10
February	193.40
March	182.10
April	167.00
May	157.00
June	145.30
July	151.50
August	162.30
September	175.30
October	202.40
November	209.30
December	231.50
Total, yr.	2190.20



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10-Candle Power.

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This lamp is a perfect substitute for the 10-candle Pentane Lamp hitherto used, and has the following advantages:

1st. It uses Standard Kerosene Oil (Pratt's Astral Oil or equivalent).

2d. It is remarkably steady. Will burn 24 hours continuously with less than 2 per cent. variation.

3d. It is much less dangerous than Pentane, which is a kind of gasolene.

4th. It is not easily affected by air currents in the photometer room.

5th. Since the lamp may burn continuously, the candle power of gas may be taken at any moment, if necessary. This insures steady illuminating power without waste of carburetting material.

6th. The first cost of the lamp brings it within the reach of even small gas works.

7th. Costs much less to maintain than a Pentane lamp or sperm candles doing the same service.

8th. Is not affected by the weather.

PUBLIC LIGHTING TABLE.

FEBRUARY, 1907.

Day of Week.	Table No. 2. NEW YORK CITY. ALL NIGHT LIGHTING. Date.	Light.	Extinguish.
		P. M.	A.M.
Fri.	1	5.05	6.15
Sat.	2	5.05	6.15
Sun.	3	5.05	6.15
Mon.	4	5.05	6.15
Tue.	5	5.10	6.10
Wed.	6	5.10	6.10
Thu.	7	5.10	6.10
Fri.	8	5.10	6.10
Sat.	9	5.10	6.10
Sun.	10	5.10	6.10
Mon.	11	5.10	6.10
Tue.	12	5.20	5.55
Wed.	13	5.20	5.55
Thu.	14	5.20	5.55
Fri.	15	5.20	5.55
Sat.	16	5.20	5.55
Sun.	17	5.20	5.55
Mon.	18	5.20	5.55
Tue.	19	5.30	5.55
Wed.	20	5.30	5.55
Thu.	21	5.30	5.55
Fri.	22	5.30	5.55
Sat.	23	5.30	5.55
Sun.	24	5.30	5.55
Mon.	25	5.30	5.55
Tue.	26	5.30	5.45
Wed.	27	5.30	5.45
Thu.	28	5.30	5.45

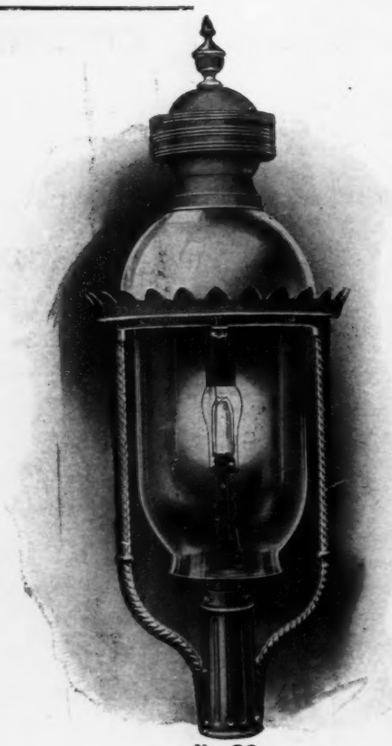
TOTAL HOURS DURING 1907.

By Table No. 2.

	Hrs.Min.
January	423.20
February	355.25
March	355.35
April	298.50
May	264.50
June	234.25
July	243.45
August	280.25
September	321.15
October	374.30
November	401.40
December	433.45
Total, yr.	3987.45

NEW YORK, 318 West 42d Street. BOSTON, 820 Beacon Building. PHILADELPHIA, Broad and Arch Streets. ST. LOUIS, 712 Ree Building. CHICAGO, 218 La Salle Street. SAN FRANCISCO, 512 Oak Street.

WELSBACH STREET LIGHTING COMPANY



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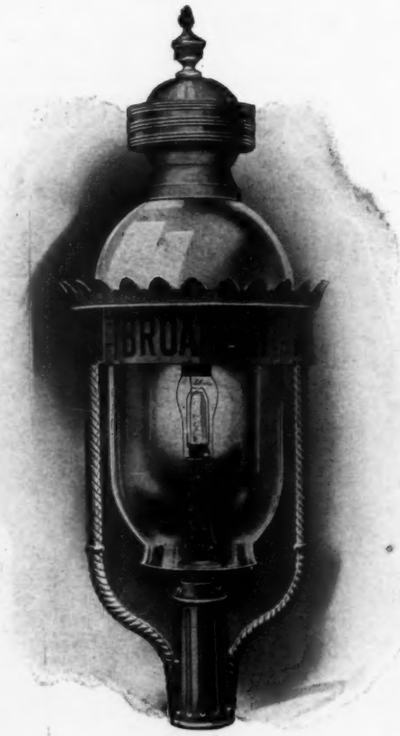

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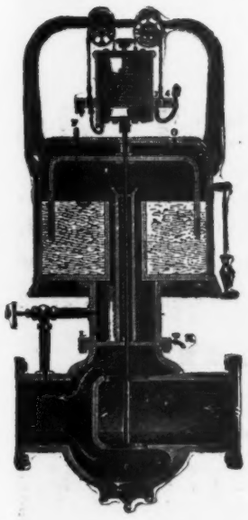

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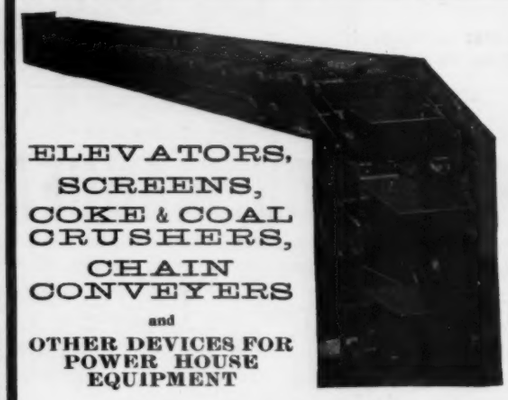

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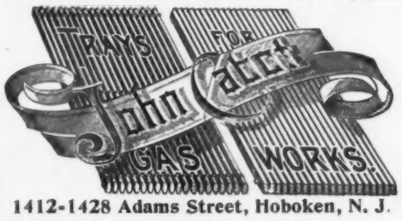

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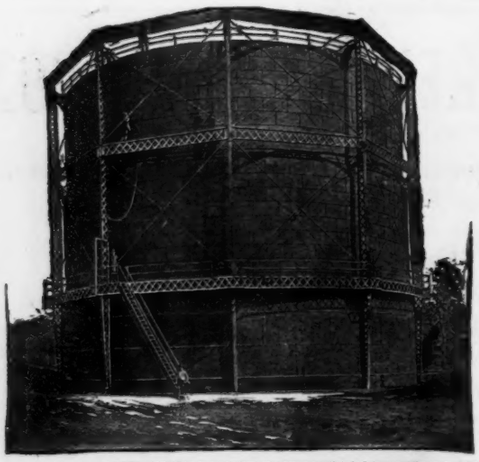

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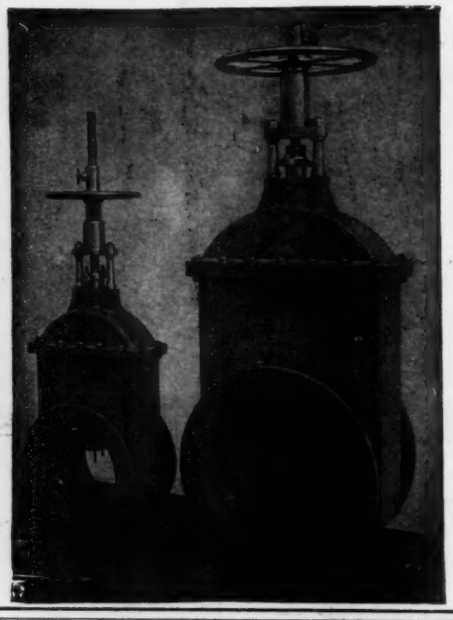

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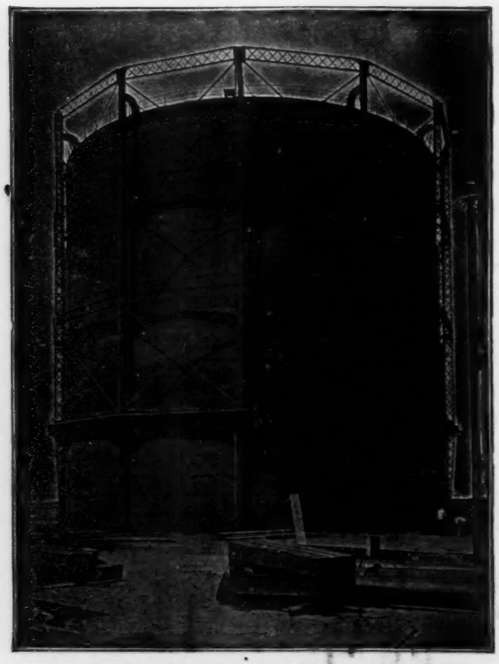

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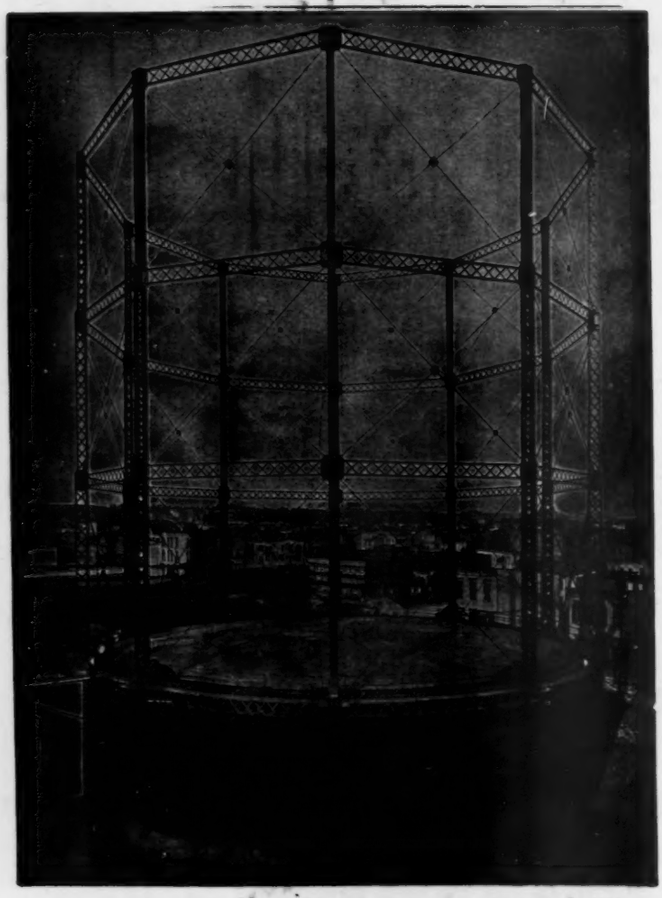

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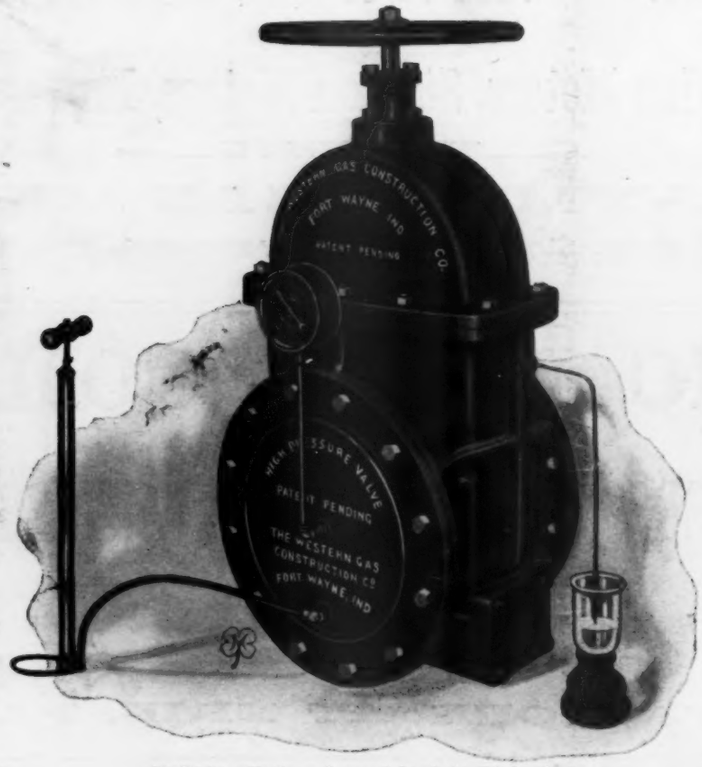

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